Route to:

Return to:

INSTITUTE OF GAS TECHNOLOGY

THE GAS INDUSTRY'S OWN EDUCATIONAL AND RESEARCH FACILITY

CHICAGO 16, ILLINOIS

GAS ABSTRACTS

APRIL, 1960

VOLUME 16 NUMBER 4

AFFILIATED WITH

ILLINOIS INSTITUTE OF TECHNOLOGY

CONTENTS

1. **Management**—Gas industry progress, business problems, statistics, government regulation, safety, personnel, education..... 73

2. **Energy Supply and Economics**—Resources, reserves, and competitive applications of the fossil fuels and other sources of energy, including nuclear and solar energy..... 74

3. **Natural Gas and Petroleum Production**—Geology, exploration, drilling, well management, reservoir engineering..... 76

4. **Gas Conditioning and LPG Recovery**—Condensate, dust, CO_2 and sulfur removal, dehydration, odorization, oil fogging, humidification; LPG recovery and refining..... 78

5. **Natural Gas Transmission**—Pipelines, compressors, dispatching, flow regulation, communications, maintenance..... 79

6. **Gas and LPG Storage**—Holders, pressure tanks, underground storage; liquefaction, refrigerated storage..... 80

7. **Manufactured Gas and Chemical Processing**—Gasification of coal, oil; reformed gas; chemical treatment; byproducts; synthesis gas production and conversion; petrochemicals; catalysts, catalyst development..... 81

8. **Gas Distribution**—City utility systems: design, operation, maintenance; weather influence on peak loads and supply; LPG-air mixtures..... 84

9. **Gas Fuel Utilization and Appliances**—Domestic, commercial, industrial; burners; combustion research; air pollution..... 85

10. **Equipment and Instrumentation**—Production and handling equipment, and maintenance; computers; controls; measurement..... 87

11. **Materials of Construction, and Corrosion**—Metals, refractories, plastics; corrosion measurement, prevention..... 89

12. **Analytical Methods and Tests**—Standard and research techniques for gas-making materials, products, processes; instrumental analysis..... 91

13. **Basic Science**—Chemistry, physics and basic engineering related to gas technology; physical properties of gases: phase equilibria, thermodynamics, reaction kinetics, heat and mass transfer, fluid flow..... 94

Services Available to Readers—Photocopies, microfilm, Russian translations, bibliographies and literature searches, *Gas Abstracts on Cards*, back numbers of *Gas Abstracts*.....**Inside Back Cover**

Publications Abstracted for Gas Abstracts.....**Back Cover**

O. P. BRYSCH, Editor P. J. CHATTA, Assistant Editor N. FELDMANN, Assistant Editor

GAS ABSTRACTS is published and distributed monthly by the Institute of Gas Technology, Chicago 16, Illinois. The contents of selected papers and patents are reviewed impartially by the editorial staff and material of potential interest to the Gas Industry is presented.

Subscription rates to nonmembers of the Institute: $18.00 per year to U. S. addresses; $22.00 foreign. Regardless of the month in which it is entered, each subscription starts with the January issue. A gold-stamped fabrikoid binder for the year, and title- and end-pages for that volume, are sent with the January issue. A complete index to the year's issues is mailed as soon after the year's end as it can be prepared, edited and printed.

Copyright 1960 by the Institute of Gas Technology. Printed in the U.S.A.

A microfilm edition of Gas Abstracts can be supplied by University Microfilms, 313 N. First St., Ann Arbor, Michigan.

1. MANAGEMENT

Federal Power Commission

Antitrust Laws and Regulated Companies under the FPC. J. K. Kuykendall. *Public Util. Fortnightly 65,* 373 (1960) March 17 (9 pp.)

The question of whether public utility companies specifically regulated under federal statutes such as the Federal Power Act and the Natural Gas Act are thereby immune to alleged violations of antitrust laws under the federal statutes against monopolistic practices and restraints of trade is discussed. The chairman of the Federal Power Commission points out several legal factors and distinctions which should be considered in any study of the problem.

Gas Confusion, Unlimited. A. K. Lee. *Public Util. Fortnightly 65,* 443 (1960) March 31 (13 pp.)

Author believes that major changes are needed to eliminate the confusion dominating the regulation of gas. He presents his own plan for producer and pipeline rate control which would simplify pipeline charges. Plan calls for four major changes: 1) producers must rescind or modify contracts which compel pipelines to take or pay for gas in the summer months; 2) pipelines must charge for firm gas at a rate reflecting only the actual field cost, plus a transportation cost; 3) direct sales by pipelines to consumers should be made jurisdictional by Congress; and 4) Congress should amend the Natural Gas Act to establish principles under which the FPC can alleviate the present log jam on producer rate cases.

Information

The Information Problem. L. W. Ross. *Chem. Eng. 67,* 143 (1960) March 21 (6 pp.)

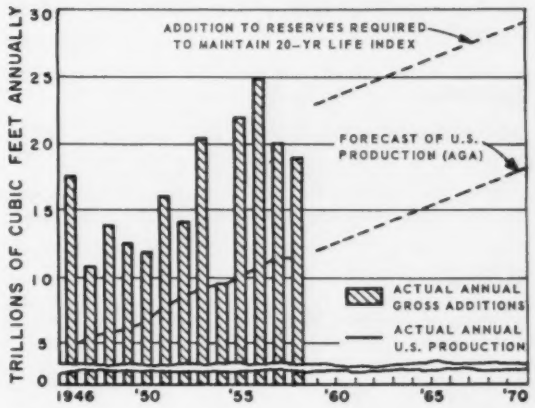
Engineers must keep up with the abundance of technical literature that is being published today. Even the smallest organization can, by proper planning, keep their engineers well informed. Any program installed should 1) enable engineers to learn of and to obtain copies of practically any information in print, and 2) bring to engineers' attention current developments in their fields of specialization. More use of libraries, abstract journals, technical magazines, literature reviews, information services, and consultation services should be made to reach these objectives.

Liquefied Natural Gas

The Economic Significance of Liquefied Natural Gas from the Distributor's Viewpoint. M. Anuskiewicz, Jr. *Gas Age 125,* 13 (1960) March 31 (9 pp.)

Author believes that although the more conventional peak-leveling methods—underground storage, LPG and oil-gas production, interruptible contracts—will retain their importance, there is a definite potential place for liquified natural gas in accomplishing a well-balanced and most economical overall supply program. Reasons are based on an intensive study of liquefaction and the other more conventional methods of peak shaving.

Annual Additions to Gas Reserves Required to Meet Forecast Production



(Adapted from *Domestic Gas Reserves' Future Gloomy . . .* See Abstract, p. 75)

Economics of Liquefied Natural Gas for Peak Shaving. A. R. Young. *Gas Age 125,* 20 (1960) March 31 (4 pp.)

With its economical pipeline system, the American gas industry is many years from the need for liquefaction as a means of obtaining import gas. However, author says, it has a valuable potential as a peak-shaving means where volume justifies the large initial investment. Article brings up-to-date author's earlier studies of production and storage costs (see *Gas Abstracts 15,* 97), and discusses various design data.

LPG

Give Us Equal Tax Break with Co-Ops, LPGA Proprietary Bloc Cries. *Butane-Propane News 22,* 48 (1960) April (3 pp.)

Article summarizes remarks of John Wallace, vice president of Petrolane Gas Service, Billings, Mont., who testified before the House Ways & Means Committee in March. He appeared on behalf of the proprietary members of the Liquefied Petroleum Gas Association and argued against the unfair advantage of co-ops. His contention: "Co-op tax-free enterprise is grabbing the largest share of new business and driving private, tax-paying free enterprise out of business."

Tuloma Predicts Huge Tanker Will Slash Transport Costs. *Butane-Propane News 22,* 44 (1960) April (2 pp.)

Union Tank Car Co. is constructing two railroad tank cars—each with a 30,000-gal shell capacity—for use by Tuloma Gas Products Co., Tulsa. This capacity is

almost three times that of today's average sized cars. When completed, these 85-ft long cars will measure 17 ft more, and have 8300-gal more capacity, than the largest railroad tank cars currently used in interchange service.

Appliances

Why Philadelphia Dealers Sell Gas Appliances. W. H. Stinsman, Jr. *Am. Gas J. 187,* 42 (1960) April (3 pp.)

Report on Philadelphia Gas Work's highly successful dealers' sales program, first instituted ten years ago.

Research

Methods of Studying Mass Fires. Second Fire Research Correlation Conference May 1957. Committee on Fire Research and the Fire Research Conference. National Academy of Sciences—National Research Council Publication 569, 1958 (48 pp.)

Conference was convened to study mass fire specifically. A mass fire is defined as a large area burning all at once and incapable of being extinguished by direct attack. A mass fire may be the result of many fires ignited within a short period of time, or of a single fire whose growth or spread is uncontrolled. Purpose of the conference was to examine the state of knowledge in mass fires phenomena, and to identify the areas most in need of research, designed to discover vital knowledge for cause and prevention on the one hand, and control measures on the other. Report gives a summary of the conference and the conclusions and recommendations of the analysts.

Coal Research

Coal Research in 1959. J. Mitchell and J. C. Quinn. Part 1. *Mining Congress J. 46,* 86 (1960) Feb. (9 pp.); Part 2. *Ibid.,* 72 (1960) March (7 pp.)

A broad, worldwide survey of coal research and development activities, this review article first describes the work carried on during the past year in the U.S. with regard to properties of coal, its production, preparation and utilization as a fuel, and its conversion to another form prior to end use. Authors then cover the activities of a number of major research centers outside the country.

Safety

Consider Safety During Engineering and Construction. J. J. Graham. *Refining Eng. 32,* C-22 (1960) March (5 pp.)

Safety measures which Standard Oil Co. follows during design and construction of a new plant are discussed. Seven steps in the chronology of a project where safety is of special importance are: 1) general engineering specifications; 2) job specifications; 3) engineering flow sheets; 4) plot plan; 5) model review; 6) construction inspection; and 7) prestartup operator training.

State Commissions

Effect on Gas Proration of Recent Special Orders. J. S. Cameron, Jr. *J. Petrol. Tech. 12,* 22 (1960) March (4 pp.)

Following a general discussion of the basic procedure used in Texas, article discusses and evaluates the new gas proration orders issued by the Railroad Commission to require ratable take in concerned gas fields.

Toxicity

Natural Gas and Odorants Do Not Harm Shade Trees. P. P. Pirone. *Gas Age 125,* 31 (1960) March 17 (3 pp.)

The widespread conversion to natural gas in recent years has raised the question as to how toxic this substance really is to trees and other vegetation. A three-year investigation shows lack of toxicity in natural gas, but confirms bad effects of manufactured gas. Accidental discovery also proves natural gas did not harm one tree exposed over a period of eight years.

2. ENERGY SUPPLY AND ECONOMICS

Competitive Fuels

Gas Heating 1959: The Best Year Yet. *Gas Heat and Comfort Cooling 11,* 29 (1960) March (9 pp.)

Out of a total of 2,061,657 automatic central heating installations last year, gas-fired equipment accounted for 64%. Oil-fired units totalled 637,057, stoker sales are estimated at 12,200, and electric heating is believed to have had 92,000 installations. Gas-fired central heating equipment accounted for 52.5% of the total automatic heating in service at the end of 1959. The 9,647,590 oil-fired installations represent an increase of 3.5% for this type of equipment, and 42.5% of the automatic heating. Stokers in operation are estimated at 548,200 (2.4%) and electric heating totals 592,000, or 2.6%.

Energy Sources

Education for Survival. A. K. Sibley and W. H. McNeice. *J. Eng. Educ. 50,* 523 (1960) March (10 pp.)

Present and future energy sources are discussed. Figures presented show that all world and U.S. normal sources of energy will yield only about 1/10 of the world's estimated requirements in the next 90 years. The relationship of population growth, standard of living and use of energy is developed. Continued advancement in the future depends upon energy and its control. Survival in the energy race thus requires that basic research be stepped up, that we start now in seriously directing the student to become the scientist, and that we make great improvements in the university undergraduate programs to save time.

Energy Research Patterns. S. H. Schurr. *Gas Age 125,* 30 (1960) March 31 (6 pp.)

History of energy use in the U.S. has a dominant

note—interfuel substitution; this resulted in the decline of fuel wood and the rise of coal, and, more recently, the growth in relative importance of oil and gas. At some future time, article predicts, atomic energy will probably gain at the expense of today's energy sources.

Fuel Technology in Canada. R. J. Brearley. Abstracted by A. Ignatieff in *Gas J. 301,* 312 (1960) Feb. 24 (4 pp.)

Canada now stands second among the countries of the world in per capita annual consumption of oil at 16.8 bbl compared with 4.7 bbl in 1939. Problem of how Canada can be self-sufficient in oil is one which affects all Canadian fuels. Author discusses present reserves, possible exploration, and research being done to supplement existing fuels. It is estimated that in 1980 energy consumption will be: coal—16%, oil—45%, natural gas—25%, wood—1%, water power—11%, and nuclear energy—2%.

Fuel Cells

Batteries with Solid Ion-Exchange Membrane Electrolytes. Part 2. Low-Temperature Hydrogen-Oxygen Fuel Cells. W. T. Grubb and L. W. Niedrach. *J. Electrochemical Soc. 107,* 131 (1960) Feb. (5 pp.)

Hydrogen-oxygen fuel cells employing a commercial ion-exchange membrane as the electrolyte are described. Some performance data on this type of cell operating at room temperature with a cation membrane in the hydrogen form and with hydrogen and oxygen at one atm are presented. The open circuit emf is about 0.3 v below the value of 1.23 expected for a versible cell. This deficiency is found to be caused by the oxygen electrode which does not achieve the reversible half-cell potential. Equilibration of the membrane electrolyte with sulfuric acid prior to cell assembly results in improved polarization characteristics. Favorable features of these cells include their simple construction and their small unit thickness.

Direct Production of Electrical Energy from Liquid Fuels. E. Justi and A. Winsel (assigned to Ruhrchemie A. G. and Steinkohlen-Elektrizitat A.G., Germany) U.S. 2,925,454 (1960) Feb. 16

A fuel cell is claimed in which liquid fuel such as alcohols, ketones, ethers, paraffins and aromatics (not over 14 carbon atoms) are dissolved (2-10%) in the 6-normal KOH electrolyte (with aid of soap solublizers) passed through a porous, skeletal Raney nickel fuel electrode and passed through the cell toward an oxygen electrode comprising a porous carbon cylinder.

Natural Gas Reserve

Future Supply and Price of Natural Gas. W. B. Golush. *Gas Age 125,* 23 (1960) March 17 (5 pp.)

Industry must intensify its exploration efforts to find an annual average of 26 trillion CF of gas over the next ten years. This is needed to back up the predicted 5% annual increase in gas demand. Wellhead prices from 18¢ to 25¢/MCF for new gas contracts seem to offer the incentive to explore for and develop new gas reserves. Average wellhead prices on all gas must rise to 23¢ within three years, and to 25¢ within the next decade.

Petroleum Refining

Annual Survey of Capacities of U. S. Refineries. *Oil Gas J. 58,* 149 (1960) March 28 (18 pp.)

New survey gives plant operating capacity and plant-by-plant listing of every type of process being used. State and national totals are given for each process discussed in the article.

Reserves

Nation's Reserves Climb to New Highs. *Oil Gas J 58,* 71 (1960) March 21 (3 pp.) **Domestic Reserves Hit New Record.** *Petrol. Week 10,* 15 (1960) March 18 (3 pp.)

U.S. proved reserves of crude oil have increased from 30,535,917 bbl on Jan. 1, 1959 to 31,719,347 bbl on Jan. 1, 1960, and natural gas reserves increased from 254,142,037 MMCF to 262,596,593 MMCF in this period despite increases in production. Natural gas liquids increased to 6,522,308,000 bbl, an increase of 318,290,000 over 1958. Revisions rather than discoveries account for most of the gains reported for the period covered.

Domestic Gas Reserves

Domestic Gas Reserves' Future Gloomy Unless Exploration Is Increased. *Oil Gas J. 58,* 160 (1960) March 14 (7 pp.)

Article, based on studies of long-range trends in the supply and demand for natural gas conducted by Phillips Petroleum Co., points out that: 1) demand is rising faster than reserves are being added; 2) full deliverability of present reserves could taper off before all present pipelines and distribution systems are amortized; 3) forecasts of ultimate reserves yet to be found ignore practical problems and economic incentive for exploration; 4) economic significance of the recent shift from shallow dry gas to deep wet gas as the major source of supply has not been fully appreciated; 5) search for oil alone will not increase gas reserves enough to keep pace with rate of consumption; and 6) revenue from gas sales must supply the major incentive to explore for new gas reserves.

Electricity

What You Should Know About Electric Heating. R. M. Wood. *Am. Gas J. 187,* 35 (1960) April (4 pp.)

Author considers the inroads that electricity has made in the space-heating field, discusses probable future trends and the factors which will determine these trends, and concludes by predicting which type of electric heating will be the most popular.

Thermoelectricity

Bibliography on Semiconductors for Thermoelectric Use. E. H. Illsley and H. Kato. *Bureau of Mines Inf. Circ.*

7910. Washington: Govt. Printing Office, 1959, $0.25 (28 pp.)

Paper lists 131 literature references and abstracts under the following headings: 1) Peltier effect; 2) thermoelectric and thermal conductivity theory and related topics; 3) experimental methods, materials, and applications, and 4) studies of tellurides and selenides.

Thermoelectric Apparatus for Cooling and Heating Liquids. C. R. Lopp and W. R. Danielson (assigned to Whirlpool Corp.) U.S. 2,928,253 (1960) March 15.

Thermoelectric apparatus is claimed for cooling and heating liquids, in which banks of Peltier couples are arranged whereby one body of fluid makes thermal contact with the hot junctions, and another body of fluid makes contact with the cold junctions. These separate bodies of fluid have their individual inlets, circulating and storage facilities, with thermoelectric controls for maintaining desired temperatures of fluid.

3. NATURAL GAS AND PETROLEUM PRODUCTION

Air Drilling

Competitive Advantage Seen for Air-Foam Drilling Work. R. W. Horton. *Drilling 21*, 80 (1960) March (2 pp.)

With the proper rotary drilling equipment and air drilling background, it has been proved that the air-foam technique can compete successfully on 4000-ft wells. In one area where another method required 80 to 120 days, air-foam cut the time to 18 to 20 days.

Drilling

Deep Drilling Finds Deep Production. E. Adams. *Petrol. Eng. 32*, B-19 (1960) March (12 pp.)

Survey of deep-well operators gives 1959 data of location, averages and descriptions of wells in the U.S. drilled 15,000 ft and below.

20 Years of Power Drilling. *Drilling 21*, 59 (1960) March (7 pp.)

The internal combustion engine has replaced steam as the prime mover of the drilling industry. This conversion has been stimulated by: 1) deeper drilling which requires heavier and more powerful rigs; and 2) expansion of drilling into areas where there is too little water for boiler use. Outline is presented of the development of engines, drawworks, mud pumps and the power transmission system. Included are figures indicating the average depth of wells in the U.S. and Canada from 1939-59.

Drilling Mud

An Improved Water-in-Oil Emulsion Mud. G. W. Grandt, D. J. Weintritt, and G. R. Gray. *J. Petrol. Tech. 12*, 14 (1960) March (4 pp.)

A water-in-oil emulsion mud free of inert solids has been developed to provide a solution to certain problems associated with drilling, completing and servicing wells. Such invert-emulsion muds are satisfactory for use in wells with temperatures up to 300°F and with pressures requiring densities up to 18 lb/gal. The emulsifier used in preparation of these muds is the mixed salts of fatty acids. It is used in weighted muds in conjuction with a unique organophilic-clay suspending agent.

Mud-Solids—Their Relation to Drilling Mud Economy. N. O. Campise. *Drilling 21*, 64 (1960) March (6 pp.)

Article presents 18 charts illustrating the need for larger daily reductions in mud solids as mud weight increases. Decreasing clay solids' concentration can be accomplished by: 1) discarding whole mud and rebuilding volume and weight by the addition of water and barite; 2) separating clay from barite and discarding the solids while leaving the barite in the active mud system; and 3) improved selective chemical treatment coupled with a centrifuge and compound to inhibit clay dispersion.

Exploration

Airborne Gravity Meter Tested. *World Petrol. 31*, 53 (1960) March (3 pp.)

Successful use of the LaCoste and Romberg airborne gravity meter over a test area has been confirmed. Paper discussed provides evidence that gravity measurements can be made from an aircraft to an accuracy of about 10 mg or better, and that reliable gravity contour maps can be constructed from such data. Actual laboratory tests, using test equipment that simulates air or sea motions, show that the instrument accuracy is better than ± 1 mg.

Dig Deep for South Dakota Pays. A. F. Agnew and J. P. Gries. *Oil Gas J. 58*, 160 (1960) March 21 (8 pp.)

Of the approximately 375 oil and gas tests drilled in South Dakota, only 58% reached the Pennsylvanian. Less than 16% of the total drilled penetrated all of the formations and reached the Precambrian. Thirty-five percent of all holes reported yields of oil or gas; however, in the Williston basin area, the strike percentage has been twice as great as elsewhere in the state. Future exploration will search for the many facies and structural traps in this area.

Kansas' Oil, Gas-Field Discoveries Continue to Mount. D. F. Merriam and E. D. Goebel. *Oil Gas J. 58*, 250 (1960) March 28 (4 pp.)

Annual crude-oil production of Kansas exceeded 100 million bbl in 14 of the last 17 years. The 1959 production is estimated at 119.2 million bbl, enough to boost the cumulative production almost to the 3¼ billion bbl mark. Cumulative natural gas production surpassed the 8 MMCF mark in 1959. Since 1956, annual production has exceeded 500,000 MMCF annually. The 1959 estimated production, worth $64.6 million, is 587,600 MMCF, an all-time high for Kansas. Exploration ac-

tivity in 1959 remained high despite adverse economic conditions in the petroleum industry. Out of an estimated 5500 wells drilled, 188 new fields were discovered, an increase of about 24% over 1958.

New Tools for the Geophysicist. *World Petrol. 31,* 48 (1960) March (2 pp.)

New equipment and new techniques in aerial and marine reconnaissance have featured geophysical progress in the past year. On water, new energy sources have been employed for mapping subsurface features at greater depths. In the air, an airborne gravity meter has been developed to the commercial stage with sufficient accuracy to permit simultaneous, high speed gathering of magnetic and gravity data. An airborne gradiometer has been announced by a Canadian physicist although accuracy data have not been released yet. New methods of positioning planes without the use of ground stations are of importance in aiding aerial reconnaissance.

The Stratigraph—a New Research Device. E. Merlini. *World Petrol. 31,* 50 (1960) March (2 pp.)

New instrument furnishes supplementary data for the correlation of stratigraphic information recorded in the normal course of seismic surveys. Basically, this new equipment summarizes and integrates, with respect to time, the energy received by all geophones on the surface spread of the conventional seismic record as it is being recorded. Summation of these results is recorded and filmed on a separate trace of the normal seismogram.

Fracturing

Effect of a Partial Monolayer of Propping Agent on Fracture Flow Capacity. S. R. Darin and J. L. Huitt. T. P. 8104. *AIME Petrol. Trans. 219,* 31 (1960) March (7 pp.)

Use of a partial monolayer of propping agent to obtain a high flow capacity for a hydraulically induced fracture is discussed. From the results of laboratory work it was shown that a modified form of the Kozeny-Carman relation could be used to describe the flow in the partial monolayer propped fracture. With equations presented, density pattern of the propping agent that results in the maximum flow capacity for the fracture can be determined.

Hydraulic Fracturing with the Single-Point Entry Technique. J. L. Huitt. *J. Petrol. Tech. 12,* 11 (1960) March (3 pp.)

Presents step-by-step description of new fracturing technique and evaluates its performance in comparison to conventional fracturing methods.

Geology

Deep Boreholes through the Earth's Crust. T. F. Gaskell. *Proceedings of the Chem. Soc.,* 100 (1960) March (5 pp.)

Suitable locations have been found in the Atlantic and Pacific where the seismic results demonstrate that only about 30,000 ft of rock need be penetrated by the drill in order to reach the valuable Moho layer. This is not much more than the record oil-well boring, although considerable extra difficulty will be encountered because of the great depth of water. New tools are being devised to further this research, such as a drilling-bit which can be folded up and withdrawn to the surface up the inside of the drillpipe.

Reservoir Engineering

Clay Mineralogy Problems in Oil Recovery. J. E. Moore. Part 1. *Petrol. Eng. (Drilling and Producing) 32,* B-40 (1960) Feb. (6 pp.); Part 2. *Ibid.,* B-78 (1960) March (6 pp.)

Author discusses the relation of clay minerals to reservoir performance. Even minor percentages of these minerals will influence the permeability of oil sand. Part 1 presents data on clay mineral evaluation, structure, and properties. Part 2 discusses how to combat swelling clays in drilling subsequent producing operations.

Development and Evaluation of Gas-Condensate Reservoirs. W. C. Goodson. Part 8. *Petrol. Eng. (Drilling and Producing) 32,* B-38 (1960) March (5 pp.)

This article, concluding a series on gas-condensate reservoirs, presents an economic analysis illustrating a comparison of three basic contracts—15¢/MCF interstate, 20¢/MCF interstate, and 10¢/MCF intrastate—during entire life of operation. The same reservoir under the same contract stipulations is evaluated by a potential buyer, having the same knowledge of the properties as the operator, to arrive at a proposed purchase price. Article concludes with a 90-item bibliography.

The Effect of Some Chemical Agents on the Permeability of Cores Containing Clays. G. G. Bernard and O. C. Holbrook. *Producers Monthly 24,* 18 (1960) March (4 pp.)

Study reported was undertaken to investigate methods of maintaining relatively high water permeability in strata containing water-sensitive clays. It was found that permeability changes caused by clay hydration are essentially irreversible. Certain chemical agents can prevent clays from hydrating, dispersing and lowering permeability; however, after these changes in clay structure have occurred, the antiswelling chemical agents are relatively ineffective in restoring the initial permeability. Neither salt water nor acid greatly increased the permeability of montmorillonitic cores that were previously exposed to fresh water.

Introduction of a Pore Geometrical Factor Defined by the Capillary Pressure Curve. Tech. Note 2057. J. H. M. Thomeer. *J. Petrol. Tech. 12,* 73 (1960) March (5 pp.)

Method presented provides a mathematical description of capillary pressure curves and of differences in pore geometry of samples. Technique is based on the observation that the location and shape of a capillary pressure curve reflect characteristics of the pore structure of the sample.

Quick, Nongraphical, Noniterative Method for Gas-Drive Predictions—Short Tarner. R. V. Higgins and A. J. Leighton. Bureau of Mines Rep. Invest. 5580. Pittsburgh: The Bureau, 1960 (18 pp.)

Previous methods have been presented to calculate oil recovery by the expansion of dissolved gas with and without return of gas to the reservoir. Although electronic computers have eliminated the tedious and time-consuming calculations required by each of these methods, many engineers do not have access to electronic computers. This paper presents a short method, using the Tarner method as a base. The permeability curve is treated as a series of linear relationships between the liquid saturation of the reservoir and the permeability ratio. Thus, the quantity of producible oil can be obtained directly by solving one equation.

Reservoir Performance under Gas Injection, LL-453, Bolivar Coastal Field, Venezuela. D. L. Stepanek. *J. Petrol. Tech. 12,* 34 (1960) March (3 pp.)

Performance history data are presented for reservoirs in the Lake Maracaibo region, showing how a gas injection pressure maintenance project is expected to increase ultimate recovery by 50%.

Secondary Recovery

Performance of Seeligson Zone 20-B Enriched Gas-Drive Project. E. G. Baugh. *J. Petrol. Tech. 12,* 29 (1960) March (5 pp.)

An enriched gas-drive project was initiated in Seeligson field, Texas, in March, 1957. To date nearly 2.5 billion CF of enriched gas mixture composed of 50% methane and 50% propane has been injected through two wells. Cumulative production since injection is approximately 750,000 bbl of stock-tank oil. Current oil-producing rate is 1000 bbl/day. Enriched gas has reached the first row of producing wells down-structure of the two injection wells. Displacement of reservoir oil by enriched gas mixture has proved to be highly efficient.

4. GAS CONDITIONING AND LPG RECOVERY

Carbon Dioxide Removal

New Costs for Hot Carbonate Process. S. Katell and J. H. Faber. *Petrol. Refiner 39,* 187 (1960) March (4 pp.)

Economics of the hot carbonate purification process for removing CO_2 are presented. Article includes discussion of three variations of the process in order to meet design specifications, which call for a feed-gas flow of 10 MMSCF/hr, with CO_2 inlet concentrations of 10, 20, and 30%, and exit CO_2 values of 5, 2, 1, 0.5 and 0.1%. Inlet pressure and temperature are 350 psig and 300°F, respectively.

Separation of Carbon Dioxide from Gaseous Mixtures. C. E. Redemann and F. E. Miller (assigned to the Fluor Corp. Ltd.) U. S. 2,926,752 (1960) March 1.

Carbon dioxide is removed and recovered from mixtures with other gases by countercurrent scrubbing in an adsorption zone at 60-600 psia with glycerol triacetate, which acts as a preferential solvent for CO_2. The rich triacetate is passed to a pressure-reducing flash vessel in which CO_2 is released as pressure is reduced. The triacetate also is beneficially cooled in the flashing stage and is recirculated to the CO_2 absorber. Vacuum or air stripping also may be used to remove CO_2 from triacetate, and this removal process may be carried out in several successive stages of decreasing pressure. Moisture, H_2S, COS, and mercaptans also are removed.

Condensate Removal

Scrubber Selection for Gas Lines. E. Sterrett. *Gas 36,* 105 (1960) April (4 pp.)

Trunkline Gas Co., faced with the problem of eventually doubling its initial throughput capacity, went outside the natural gas pipeline market to investigate the possibilities inherent in equipment performing an operation similar to scrubbing. Two separators, used in central power plants to remove entrained moisture from steam over boilers or banks of steam generators, were found to handle widely varying steam flows with relatively slight changes in pressure drop or in effectiveness. As of the end of 1959, Trunkline had installed nine of these "steam" separators in place of conventional gas pipeline scrubbers. Article describes operation and cost.

Dust Removal

Settling Chambers for the Collection of Grit. R. Jackson. *B.C.U.R.A. Monthly Bull. 23,* 349 (1959) Aug./Sept. (17 pp.)

Design and examples of settling chambers for collection of various industrial dusts are discussed. Equipment ranging from simple flue enlargements to penthouses and baffled boxes is described, and efficiency of settling of various arrangements is reviewed from modern references.

Hydrogen Sulfide Removal

Gas Purification. A. L. Kohl and F. C. Riesenfeld. (New York: McGraw-Hill Book Co., 1960) 556 pp. $15.00.

This book serves as a compendium of the present-day processes for removing gaseous impurities from fuel gases, i.e., hydrogen sulfide, with brief, but adequate, treatment of theory and much supporting engineering data for the design and operating engineer. The subject matter is grouped according to apparent industrial importance into absorption, adsorption and chemical conversion techniques. Subject matter includes: ethanolamines for H_2S and CO_2 removal; applications of ammonia solutions, alkaline salt solutions and water for similar uses; sulfur dioxide removal; dry oxidation; modern liquid processes for removal by oxidation; removal of basic nitrogen compounds from gas streams; absorption of water vapor by dehydrating solutions; gas dehydration and purification by adsorption; catalytic conversion of gas impurities; and miscellaneous gas purification techniques. Each chapter includes a current reference list.

Purification

The Relationship Between NO-Content of Coke Oven Gas and Gum Formation. D. P. Banerjee. *Gas- u. Wasserfach 101,* 261 (1960) March (3 pp. German text.)

Report of studies conducted at the Bremen gasworks on the occurrence of vapor phase gum in coke oven gases. This gum has caused distribution problems because of deposits in meters, regulators, valves and pilots. It is formed by reaction of nitrous oxide with unsaturates (principally cyclopentadiene and styrene) in the presence of water, oxygen, and HCN during periods of quiescent storage in gasholders. Bremen studies indicate a yellow-brown gum, averaging 1 mg/100 CF and 92% soluble in ammonia, with 1% ash content and always containing nitrous oxide.

5. NATURAL GAS TRANSMISSION

Automation

Four-State Microwave System Marks Start of Broad Columbia Gas Automation Program. *Gas Age 125,* 28 (1960) March 31 (3 pp.)

A 470-mile microwave system, designed for 240 communication channels, has been started as part of a broad automation program by the Columbia Gas System. First leg in Kentucky and West Virginia will cost $875,000. Estimated cost of the completed project, which will also encompass Pennsylvania and Ohio, is $1,500,000. Operating on direct current, the system will work in the 6000-mc band, subject to FCC approval.

Communications

Petroleum Industry Use of the Radio Spectrum. National Petroleum Council Committee on Use of Radio and Radar (1959). Washington: National Petroleum Council, 1960 (40 pp.)

Report reviews past and present uses of radio and radar in the oil and natural gas industry, examines the probable future needs, and studies the problems which pose threats to the industry's continued effective use of radio and radar. Applications of radio in exploration, drilling, producing, transportation, refining, and marketing are discussed fully. Eight recommendations are offered to solve the problem of intensity of competition for radio channels.

System Concepts for Automatic Pipeline Control. D. E. Dufford. *Pipeline Eng. 32,* D-18 (1960) April (5 pp.)

Automatic control systems for existing and new pipelines should be systems embodying advanced and tested concepts in control based on specific requirements of pipeline operation. Control system cost is kept at a minimum by the use of two basic concepts: 1) total equipment requirements are kept low by permitting components to share control functions; and 2) by employing an "evolutionary" concept, the control system can be supplied with a basic nucleus of equipment to meet initial requirements. Additional equipment can then be added as desired to meet changing requirements. This enables the basic system to be greatly expanded at relatively small additional cost.

Compressor Stations

Columbia Gulf Transmission Aims for 'Total' Automation. *Gas Age 125,* 29 (1960) March 17 (2 pp.)

Complete automation of the intial five semi-automatic reciprocating stations of Columbia Gulf's 841-mile mainline will be completed this summer. Control of the entire pipeline, which extends from South Louisiana to the Kentucky-West Virginia line, is achieved from a central dispatching headquarters at Nashville, Tenn. Two transport measuring stations have no operators or attendants. Automation has paid off in: 1) stabilized operating costs; 2) safer, more versatile operations at higher levels of performances; and 3) allowing available manpower to be put to greater and broader use.

Pneumatic Control Systems for Semi-Attended Field Stations. I. Schmitt. *Gas 36,* 99 (1960) April (6 pp.)

El Paso Natural Gas Co.'s Panoma No. 2 compressor station, a small field installation in the Texas Panhandle, is designed to deliver 50 MMCF/day from the 220-psi gathering system to the original Panoma station located 26 pipeline miles downstream. Compression equipment consists of three 660-hp single-stage reciprocating compressors. No remote control or telemetering facilities have been provided. Main consideration was to make the station easy to operate during the attended periods of its operation, as well as adequately protecting and loading the equipment while it operates unattended.

Dispatching

Installing and Operating the First Computerized Gas Dispatching System. R. Silkensen. *Am. Gas J. 187,* 25 (1960) April (4 pp.)

Description of the operations of the Public Service Co. of Colorado and of the installation of the Libratrol-500, first computerized system to be applied to on-line gas dispatching. Because this installation has just been completed, comparative data on performance of the computer system cannot be provided. However, detailed pictorial report of the new gas dispatching operation is included.

Fluid Flow

A New Method for Calculation of Pressure Drop in Pipelines. P. Renouard. *J. Industries du Gaz 84,* 47 (1960) Feb. (5 pp. French text.)

A simplified formula and its derivation are discussed for the graphical calculation of pressure drop in pipelines. This is derived from the theory of fluid flow, and graphs are given to show the influence of roughness and diameters, and to compare results of other investigators as well as with those of author's earlier work.

Pipeline Construction

Barge Pulls Underwater Pipeline 19 miles. *Construction Methods and Equipment 42,* 132 (1960) March (3 pp.)

Pipeliners working in the Persian Gulf claim a new record for the longest continuous pipeline pull. They hauled a 30-in. diameter line between the coast of Iran to an island 19 miles offshore. Contractors set up a base on the island of Khargu, about three miles closer to shore than the terminus of Kharg. First they pulled a string of pipe the three miles between the two islands. Then they made the 19-mile continuous pull from Khargu to the mainland and connected the two underwater sections with a two-mile overland link on Khargu.

Transwestern Ahead of Schedule Despite Adverse Weather. F. H. Love. *Pipeline Eng. 32,* D-33 (1960) April (6 pp.)

Adverse weather conditions consisting of snow, mud, and high winds, have caused personal inconvenience to workmen, but have not materially slowed overall construction progress on Transwestern Pipeline Co.'s 1800-mile plus gas transmission system to the West Coast. Completion of the project is now scheduled for July, well ahead of the original target date. Author discusses general facts about the pipeline, including: pipe, welding, coating and wrapping, gas supply, special sand construction, and major river crossings.

Pipeline Systems

Soviet Gas Pipelines. D. J. Frendzel and A. Gakner. *Pipe Line News 32,* 39 (1960) March (3 pp.)

Three 40-in. high-pressure gaslines, totaling over 3000 miles, will extend across the USSR by 1965. The first of the large-diameter lines, started in 1959, will bring gas from the Krasnodar area in the North Caucasus to feed the 250-mile, 32-in. Moscow circumferential gasline scheduled for completion in 1962. The second and third lines—from the Gazli field in Uzebekistan, Soviet Central Asia—the 1300-mile line to Sverdlovsk and the 1120-mile line to Chelyabinsk, will help supply the capacity to provide the industrial centers of the Urals with about 18% of the Soviet gas production in 1965.

Telecommunications

New Canadian Gas Telemetering System. *Gas J. 301,* 315 (1960) Feb. 24 (2 pp.)

Northern Ontario Natural Gas Co. and Twin Cities Gas Co. have installed a telemetering system at a cost of $65,000 to supply a maximum of 73 MMCF of natural gas to 4300 customers. With the installation and completion of 33 natural gas distribution systems, extending a distance of 1165 miles, the system of load balancing was imperative to maintain operating pressures, a constant high load factor, and to make certain that companies did not exceed their daily contracted supplies.

Telecommunications in the Gas Industry. G. M. Rimmer. *Gas J. 301,* 394 (1960) March 9 (8 pp.)

Author presents an account of how telecommunications are likely to interest the gas industry, and the underlying principles on which their use depends. Brief lists are given of factors of mathematical theory, signals, sub channels, codings, and systems reliability.

Telemetering

How Magnolia's Remote Station Controls Work. G. J. Dorris, Jr. and R. G. Smith. *Pipeline Eng. 32,* D-26 (1960) April (4 pp.)

Two-terminal, 10-repeater microwave system discussed provides communications for control and telemetering between Corsicana and Beaumont, Texas. System includes adequate provisions for voice and other communications requirements. During the first year of operation microwave system suffered outage time of 32 hours, giving a continuity percentage figure of 99.64%.

6. GAS AND LPG STORAGE

Gas Holders

New Spherical Gasholder for Saargas Supply of the BASF. O. Schulze-Dirks. *Gas- u. Wasserfach 101,* 264 (1960) March 11 (3 pp. German text.)

Features of design, calculations, construction, pressure testing, stress measurements and start-up operations are given for the new one-million CF-capacity spherical holder of the BASF at Ludwigshafen.

Liquefied Methane

Japs to Get into Liquid-Methane Picture. *Oil Gas J. 58,* 116 (1960) March 28

Bridge Stone Tire Co., Japan, has announced its plans to import 135,000 tons of propane a year from Kuwait from supplies furnished by British Petroleum Co. The LPG will be moved in a new 15,000-ton refrigerated tanker which the rubber company plans to build, which will be designed for future handling of liquefied methane.

Liquid Nitrogen

Method of and Apparatus for Recovering Nitrogen from Air by Use of a Cold Boiling Liquid Such as Nitrogen. W. L. Morrison (assigned to the Union Stock Yard and Transit Co. of Chicago) U. S. 2,926,501 (1960) March 1.

In a refrigeration system in which liquid nitrogen is used as a refrigerant, an improved nitrogen make-up process is claimed to replace nitrogen gas lost to the cooled product and by purging. The make-up system comprises a system for compressing air to 100 psig, after cooling with water, drying the air, then heat-exchanging to −227° F by expanded oxygen from previously liquefied air, then heat-exchanging to −249° F with liquid nitrogen, separating liquid oxygen at base of a vertical column and gaseous nitrogen at the top at −249° F and discharging the recovered cold nitrogen into the nitrogen liquefaction system.

Storage

Storage of Explosive Gases. A. V. Grosse and A. G. Streng (assigned to Research Institute, Temple University.) U.S. 2,928,529 (1960) March 15.

An endothermic gas, sensitive to explosive decomposition, such as ozone or ClO_2, may be sorted in an improved manner under pressure. This is accomplished by confining the gas in a storage cylinder completely filled with hollow particles of inert solid material (alumina) of 50-10,000 microns diam, of as low a surface area and as large a total void space as practicable, but with diameter of void spaces being no greater than the quenching distance of the gas.

Tank Storage

Storage Tank for Low Temperature Liquids. R. S. Rae (assigned to The Garrett Corp.) U.S. 2,928,254 (1960) March 15.

Low-temperature liquefied gases (hydrogen) are stored in a double-walled tank, with evaporation losses reduced, or at least held to a minimum, by a circulation of refrigerant in the space between the tanks. This circulation is supplied by a pump through a heat exchanger. The pump is driven by an expansion turbine which further cools the stored gases by heat exchange with an expanded refrigerant (helium).

Tank for Storing Low Temperature Liquids in Ambient Surroundings. R. S. Rae (assigned to The Garret Corp.) U.S. 2,927,437 (1960) March 8.

Low-temperature liquefied gases (hydrogen) are stored in a tank having an inner main storage tank and an outer skin. In addition to insulation on the inner tank, there is a separate insulating layer between the inner and outer tanks with inner passages on its inner surface and outer passages on its outer surface. Gas which evaporates from the inner tank is circulated through inner passages of insulation and is passed through a low-temperature heat exchanger. A portion of the evaporated gas is bled to the outer passages of the insulation and is circulated after warming (by a combustion heat exchanger), thereby preventing frost formation on the outer skin of the tank.

Underground Storage

Aquifers for Underground Natural Gas Storage. J. A. Kornfeld. **Part 1. Need for Gas Storage; Types of Storage; History of Aquifers.** *Am. Gas J. 187,* 45 (1960) April (4 pp.)

Since 1953, when the first major natural gas aquifer storage project was put into operation near metropolitan Chicago, this type of underground storage has found widespread application. Author describes five important storage aquifers: Herscher Dome, Redfield, Florissant, Doe Run and Troy Grove.

Michigan Consolidated Doubles Storage Compressor Capacity at Six Lakes. *Gas Age 125,* 26 (1960) March 31 (3 pp.); **World's Biggest Underground Storage Compressor Plant Totals 40,000-HP.** *Am. Gas J. 187,* 66 (1960) April.

Michigan Consolidated Gas Co. has completed a $4,800,000 project to bring the total pumping facilities at its Six Lakes Station to 40,000 hp, 25% more than the next largest underground storage compressor facility. The company has now invested nearly $20,000,000.

System and Method of Detecting and Controlling Leakage from an Underground Storage Cavern. C. W. Hubbell (assigned to Phillips Petroleum Co.) U.S. 2,928,247 (1960) March 15.

In a mined storage cavern for volatile hydrocarbons, which is overlain by a porous water-bearing formation, a well is drilled to the porous formation and the water, with any escaped hydrocarbons, is pumped to the surface where an analyzer is used to detect the hydrocarbons.

7. MANUFACTURED GAS AND CHEMICAL PROCESSING

Acetylene

Half-Dozen Derivatives Shape Acetylene's Market Growth Prospects through '65. *Chem. Week 86,* 45 (1960) March 26 (15 pp.)

Acetylene's future as a major chemical raw material in the next half-decade shapes up this way: increasing competition from ethylene, propylene and other olefins. This, coupled with the increase in methods of converting hydrocarbons into acetylene and the increase in manufacturing costs, cloud acetylene's future. Article describes market prospects for acetylene derivatives; future of calcium carbide vs hydrocarbon conversion processes for acetylene production; and plant expansions underway or planned.

Carbon Black

Apparatus for Making Carbon Black. P. W. Robinson and R. E. Smith. U. S. 2,926,073 (1960) Feb. 23

Improved furnace for manufacturing of carbon black is claimed, comprising a horizontal combustion chamber heated by gas burner at one end, banks of tubes placed transversely of the chamber with upper ends opening into header chambers and lower end opening into collecting hoppers for the carbon. Natural gas is fed into first header, partially cracked and flow reversed through the next two banks and header, and reversed again through the last tube bank, with carbon falling from tubes into lower hoppers and hydrogen byproduct collected at final tube bank for return to heating burner.

Catalysts

The Structure of Cracking Catalysts. A. Fiumara and G. Salvi. *Rivista dei Combustibili 14,* 5 (1960) Jan. (25 pp.; Italian text.)

Article discusses the contrasting theories used to explain the activity of silica-alumina base cracking catalysts. The presence of active centers, of the Bronsted's acid type, considered, until a few years ago, as responsible for the activity of these substances, has now been questioned by many investigators who ascribe the catalytic action to the presence of the Lewis' acid type. A review of results emerging from research per-

formed very recently, using an extremely wide range of techniques, would point to the simultaneous presence of both types of acidity, one or the other being dominating according to the degree of dehydration of the catalyst concerned.

Coal Carbonization

Shut-Down of a Gasworks. M. W. Wesley. *Gas J. 301,* 438 (1960) March 16 (3 pp.)

Objectives of the shutdown of British base-load station producing 7 MMCF gas/day were: 1) to renew a purifier box cover; 2) to connect two second-hand static washers into the gas stream; and 3) to modify connections between the static washer and the liquid purifier. During the 15-day shutdown a total of 56 other jobs, repairs and modifications were carried out. Article discusses entire operation, from the closing of the first retort to final adjustment before starting up again.

Desulfurization

Process for Maintaining High Level of Activity for Supported Manganese Oxide Acceptors for Hydrogen Sulfide. J. D. Batchelor, G. P. Curran and E. Gorin (assigned to Consolidation Coal Co.) U.S. 2,927,063 (1960) March 1.

In a process for desulfurizing carbonized solids by passing them, mixed with supported manganese oxide as an H_2S acceptor, through a recycled flow of hydrogen at 1100° F, an improvement is claimed. This comprises separating part of the sulfided acceptor (by size or gravity difference) from the char, heating the acceptor to 1300-1600° F to burn out the sulfur, and leaching out oxidized manganese by concentrated nitric acid. The cleaned supports are reheated to vaporize the acid and to redeposit and oxidize manganese on them, and the reactivated acceptor is returned to the char stream.

Ethylene

Ethylene . . . What You Should Know. C. H. Davenport. *Petrol. Refiner 39,* 125 (1960) March (20 pp.)

Special report gives complete summary of ethylene uses, production and consumption patterns and technology. Techniques of cracking, purification and separation are covered, along with descriptions of commercial manufacturing processes and a comprehensive bibliography.

Gasification

Heating Gases and Vapours. M. Maccormac and A. G. Carter (assigned to The Gas Council.) U.S. 2,927,847 (1960) March 8.

Cyclic process for heating gas or vapor to a high temperature is claimed which uses two separate beds of heat storage material in a cycle having two major periods. During the first major period, air is passed through the first bed (regenerator) which has been previously heated. The air is burned with fluid fuel, and the hot products are passed through the second bed to heat the mass. During the second period, the first bed is isolated, air is burned with fluid fuel, and the hot products are passed through the first bed in the opposite direction. At the same time, the steam, or gasifying medium, is passed through the second bed, also in the opposite direction to first period flow, and oil is injected above the second heat storage mass to react with steam.

Hydrogen

Pilot Plant Data for Hydrogen Isotope Distillation. T. M. Flynn. *Chem. Eng. Progress 56,* 37 (1960) March (5 pp.)

Recent careful work on the ideality of mixture of H_2 and HD has made it possible to accurately evaluate the vapor-liquid equilibria of the H_2—HD system. With this information, it is possible to show that the separation by fractional distillation is not a difficult one and that the number of equilibrium stages required is not large. Data discussed coupled with the growing experience in handling liquid H_2 can be used in the design and operation of reliable and efficient H_2 distillation plants. These plants, which can be made either parasitic to or independent of large H_2 sources, will combine the merits of short equilibrium time, relatively low capital investment and low unit cost of heavy water.

Hydrogenation

Hydrogenolysis of Higher Phenols to Lower Homologues. Part 1. Factors Affecting Hydrogenolysis. N. C. Saha, N. G. Basak and A. Lahiri. *J. Sci. Industr. Res.* (India) *19B,* 67 (1960) Feb. (5 pp.)

The possibility of obtaining valuable products like phenol and cresols from tars resulting from the low-temperature carbonization of coal by the technique of catalytic hydrogenolysis in a pressure autoclave has been demonstrated. This paper deals with the influence of temperature, pressure, time of reaction, selectivity of catalyst, diluents, etc. on the conversion of higher tar acids to lower phenols. It has also been shown that hydrogenolysis of carbon to carbon or carbon to oxygen linkages in phenols is a function mainly of the 'specificity' of the catalysts used.

Nuclear Techniques

Irradiation Reactions in Hydrocarbon Gases. F. W. Lampe. *Nucleonics 18,* 60 (1960) April (6 pp.)

Secrets of radiation-induced ion-molecule and free-radical reations are being discovered as 2-Mev electrons bombard methane, neopentane, ethylene and mixtures of ethylene with argon and propane.

Oil Gas

Oil Gas Plant. J. Wilkinson. *Gas World 151,* 320 (1960) Feb. 20 (3 pp.)

Paper describes installation and operation of a plant for the production of town gas from oil by the catalytic cracking process at Meadowhall gasworks, England. Installation comprises two ONIA-GEGI plants (capacity 5MMCF/day), and auxiliary plant housing condensers, scrubbers, naphthalene washer, etc. Features such as

the water cooling and recirculating system, tar separating and treatment system, automatic operating system, and instrumentation and control panel are described.

Process of Thermally Cracking Liquid Hydrocarbons. F. Totzek, Germany. U.S. 2,926,077 (1960) Feb. 23

An oil gasification process is described in which a carrier gas (CO and H_2) and steam preheated to 1100°-1200°C are mixed homogeneously with the liquid hydrocarbon (Bunker oil) in weight ratio of 2.5-5.0 to 1 and injected downward into enlarged reaction chamber, and the products cooled to above 100°C, and electrostatically purified. Oil and residues are collected and recharged with the liquid hydrocarbons. Oil gas also may be generated at the base of the reaction chamber (below primary injector) by oil-oxygen burner.

Ore Reduction

Ferrocoke from Lignite and Magnetite Ores of South India. H. C. Nandi and M. S. Iyengar. *J. Sci. Indust. Res.* (India) *19A*, 84 (1960) Feb. (4 pp.)

Studies have been carried out on the manufacture of ferrocoke from South Arcot lignite and Salem magnetite ore with a view to using it in iron and steel industry. It has been found that straight blends of lignite-magnetite containing up to 15% iron ore yield ferrocoke briquettes of compressive strength 1000 lb/sq in., and 64% of the ore in the briquette is reduced to metallic iron. Iron ore concentration can be doubled by mixing 10% of high or low volatile coking coals without weakening the ferrocoke briquettes. Ferrocoke obtained with lignite-slaked lime-iron ore in the ratio 70:15:15 is similar in strength to that obtained with lignite-iron ore in the ratio 85:15. Increase in the concentration of slaked lime to 30% adversely affects the strength of the ferrocoke.

Iron Processes Bypass Blast Furnace. *Can. Chem. Processing 44*, 55 (1960) March (7 pp.)

Success of the two new iron-smelting processes, one of them new to the industry, could foreshadow an eventual end to the conventional blast furnace and its attendant coke ovens. Both processes are based on what is commonly called the direct reduction method. The two projected Canadian mills are smaller and cheaper compared with the huge, high-first-cost blast furnaces, long the basic pig iron producer of the iron and steel industry. Supporters of these processes—the Strategic Udy "universal smelting-refining process" and the HyL natural gas-sponge iron process—say that these techniques are ideally suited to Canada where the local market tends to be relatively small (less than 1000 tons/day) and where geography plays an important role in the cost of the various sources of energy and in the cost of iron ore.

Peak Load Gas

NEGEA Plymouth Division Installs Automatic Propane-Air Peak Shaver. *Gas Age 125*, 24 (1960) Mar. 31 (3 pp.); **New Standby Plant Features Fully Automatic Control, Constant Btu Content.** *Am. Gas J. 187*, 39 (1960) April (2 pp.)

New England Gas and Electric Association's standby gas facility for emergencies at Plymouth, Mass., is a high-pressure, fully automatic, propane-air system, one of the few U.S. installations. Adjusting propane and air pressures instead of flow rates, the plant will go into full operation 65 sec after the natural gas pressure drops to a predetermined level, and will adjust to the desired Btu content with 30 sec, maintaining that content within ±2% at all times.

Petrochemicals

Hydrogen Peroxide from Petrochemical Sources. P. W. Sherwood. *Chem. Process Eng. 41*, 89 (1960) March (4 pp.)

Recent manufacturing processes developed for hydrogen peroxide from petrochemical sources are described. New uses of H_2O_2 for propulsion purposes, chemical syntheses, foaming of rubber latex, etc., have increased production from 15 million lb. in 1948 to 54 million lb. in 1958. Predominant use, however, continues to be in the textile industry for bleaching of cotton. Most H_2O_2 is manufactured by electrolytic methods involving intermediate production of salts of peroxydisulfuric acid.

Process Design

Petrochemical Process Engineering. E. E. Ludwig. *Refining Eng. 32*, C-8 (1960) March (6 pp.)

Process engineering is the application of engineering talents to planning, design, and decisions required for a process project. Duties of the process engineer are discussed. A time study of eight process engineers handling small and large projects is presented for estimation of the approximate total man-hours expected for the total process engineering activity. Figures given illustrate possible work scheduling, typical man-hour patterns, and process engineering costs.

Producer Gas

Large-Scale Manufacture of Cold Clean Producer Gas. E. Keast and N. A. Halder. *Gas World 151*, 439 (1960) March 12 (3 pp.)

A description is given for an external producer gas plant for the firing with cold, clean producer gas of three batteries of horizontal chambers, each designed to produce 3.3 MMCF/day of coal gas, and to supply up to 1.5 MMCF/day of producer gas for dilution purposes.

Refinery Gas

The Treatment of Refinery Gas for a Commercial Outlet. I. F. S. Robinson and P. R. Johnson. *Gas. J. 301*, 357 (1960) March 2 (6 pp.)

Article describes arrangements made at the Esso Petroleum Co.'s refinery in England for the supply of refinery gas to the Southern Board's gasworks at Southampton. Because there is no storage of gas at the refinery, a system has been devised by which gaseous byproducts from several sections of the refinery are collected into a gas main at a pressure of 45 psi and distributed to

various consumers. An excess pressure in the main is neutralized by opening a safety valve and bringing a flare into operation; any reduction in pressure is compensated by the evaporation of propane into the main. Difficulties with the installation for supplying the gas are described. These include metering accuracy, freezing up of valves, and maintenance of supply within the quality limits. Typical analyses of the gas streams are presented in tabular form.

8. GAS DISTRIBUTION

Distribution Systems

Advanced Planning Saves Money in Conversion to Natural Gas. C. W. Davis. *Gas Age 125,* 17 (1960) March 17 (5 pp.)

Article describes Peoples Gas System's conversion of its Florida service area to natural gas.

Brooklyn Union's Jamaica Bay Line Construction to Climax Intricate Assignment in Planning. R. J. Wheeler. *Am. Gas J. 187,* 49 (1960) April (3 pp.)

Construction has begun on Brooklyn Union Gas Co.'s new Jamaica Bay Line, a 30-in. 350 psi main that will extend from an existing 30-in. spur in Bayridge to the company's franchise boundary in Queens. During 1960, 11 miles of this line will be laid.

Mains

Searching for Buried Mains and the "Gaz de France" Mains Detector. F.-R. de Brem. *J. Industries du Gaz 84,* 52 (1960) Feb. (4 pp. French text.)

Discussion of principle of construction and operational results obtained with an electromagnetic detecting apparatus. The device has been in service with "Gaz de France" for a decade, and has proved better adapted to its role than the detectors ordinarily used in the search for metal minerals.

Metering

Automatic Gas Flow Computations. R. H. Levis. *Pipe Line News 32,* 46 (1960) March (4 pp.)

Automatic flow computations can alleviate complex dispatching problem, says author. Operator can dispatch the gas more economically because information is accurate and up-to-date; calculations are more reliable because the flow measurements are continuously corrected for each variable. Although the original design considerations for the gas flow computer evolved from natural gas industry requirements, this system can be applied to gas flow measurements in practically every industry.

Denver's Newest Hotel Has Denver's Biggest Gas Meters. G. Telgmann. *Am. Gas J. 187,* 53 (1960) April (2 pp.)

Two Connersville rotary-type meters—each weighing 3500 lb—have been placed into service by the Denver Public Service Co. of Colorado. Each meter can handle 111,000 CF/hr of gas and provides accurate measurement with as much as a 100 to 1 turndown.

Remote Reading of Large Industrial Gas Meters by Telephone. E. Tornquist. *Am. Gas J. 187,* 33 (1960) April (2 pp.)

Description of program being studied by Northern Illinois Gas Co. to develop a system for the specific purpose of reading about 60 large industrial gas meter installations that have to be checked daily, including Saturdays and Sundays. Telephonic system consists of three units: transmitter, telephone converter and readout.

The Changing Face of Meter Reading, Data Processing, and Billing. E. D. Nuttall. *Gas 36,* 43 (1960) April (6 pp.)

Technical and economic advantages of meter reader's recorder, developed by United Gas Corporation, are discussed. Recorder utilizes ¼-in. magnetic tape, four tracks, and a special code. Three of its seven knobs can be adjusted to a number code that corresponds to the respective customer's number. The other four knobs are adjusted to agree with the customer's meter reading. When the proper mechanism is activated, the numbers are recorded on the tape. At the office, the tape is placed on a playback unit which changes the recorder code into computer language and reads it into a system for computing and printing.

Plastic Piping

Plastics Pipe Relines Save Half. *Gas 36,* 53 (1960) April (2 pp.)

More than 655,000 ft of plastics pipe has been utilized by the Public Service Co. of Colorado in Denver residential areas for relining corroded steel service or for new direct-burial gas service lines. Plastics pipe used is 0.75-in. Tenite II, Formulation #435, flow M.H. butyrate transparent plastics tubing. Article discusses cost savings and other advantages.

Vancouver Island, Canadian Pioneer with Plastics Pipe. G. Matthews. *Gas 36,* 55 (1960) April (3 pp.)

Description of Vancouver Island Gas Co. Ltd.'s experience with the adoption of plastics pipe in Canada. Since November 1958, almost all service connections from its steel distribution system are plastics pipe, and since September of the following year, plastics mains have been installed on a limited basis.

Piping

Wisconsin Public Service Adopts Plastic Tubing for Service Renewals. T. J. Lambeck. *Am. Gas J. 187,* 29 (1960) April (4 pp.)

Butyrate plastic tubing for renewals of low-pressure gas service lines has been adopted by Wisconsin Public Service Corp. in three areas: Sheboygan, Oshkosh and Green Bay. These areas are now served with natural gas. As the company's two other divisions, Stevens Point (propane-air gas) and Marinette-Menominee (water gas and propane-air gas mixture) are converted to natural gas, it is expected that butyrate tubing will also be authorized for use in renewing corroded metal services in them.

9. GAS FUEL UTILIZATION AND APPLIANCES

Air Pollution

Sixth Technical Progress Report. W. L. Faith and N. A. Renzetti. Rep. No. 30. San Marino, Calif.: Air Pollution Foundation, March 1960 (81 pp.)

Report reviews work sponsored by the Air Pollution Foundation during 1959 and other pertinent studies. The first chapter presents a resume of research done on the photo-oxidation of hydrocarbons. Chapter 2 reviews the study of the catalytic treatment of motor vehicle exhaust gases, work done on the use of foamed metals to deactivate lead in exhaust gases, status of commercial exhaust control devices, and other proposed methods of reducing contaminants in motor vehicle exhaust. Chapter 3 reviews the work of various laboratories in the field of atmospheric photochemistry. The final chapter discusses California's new ambient air and motor vehicle exhaust standards. A bibliography of the more important air pollution publications of 1959 is included.

Burners

Annulus Type Burner Assembly with Face Cooling and Replaceable Inner Tip. D. B. Eastman, C. P. Marion and W. L. Slater (assigned to Texaco Inc.) U. S. 2,928,460 (1960) March 15.

A burner structure similar to U. S. 2,928,459 (below) is claimed, with the added improvement that the outer gas supply tip is expanded into a hollow, water-cooled face plate which protects the inner oxygen-tube tip.

Annulus Type Burner Assembly with Replaceable Inner Tip. D. B. Eastman and W. L. Slater (assigned to Texaco Inc.) U. S. 2,928,459 (1960) March 15.

A burner structure for synthesis gas generation by partial oxidation of a gaseous hydrocarbon is claimed, with the improvement that the inner (oxygen) conduit of the burner is easily replaceable, and is locked by lugs in spaced longitudinal and radial position within the outer conduct to define an annular gas supply passage.

Clothes Dryers

Automatic Lint Remover. C. A. Cobb and H. H. Morris (assigned to Whirlpool Corp.) U.S. 2,925,664 (1960) Feb. 23.

Lint is removed from the discharge air stream of a domestic clothes dryer by passing the air through a conduit and then through a porous membrane which is moved as a continuous belt over the cross-sectional area of the conduit. The membrane is formed of combustible material, and is directed, with its accumulation of lint, to a separate combustion chamber.

Controls

Automatic Controls for LPG Heating Equipment. L. W. Davidson. Part 1. *Butane-Propane News 22*, 33 (1960) Feb. (4 pp.)

Automatic controls for LPG appliances are selected on the basis of safety and comfort. Commonly these are electrically operated and may be low-voltage (25v) or line voltage (240 or 120v). They are operated by expanding fluid pressure or by thermocouple voltages. Setting and adjustment of such controls are outlined in the article.

Flame Research

Carbon Formation in Premixed Flames. P. H. Daniels. *Combustion and Flame 4*, 45 (1960) March (5 pp.)

Examination of the work of earlier investigators on the suppression of carbon in premixed flames has shown that there is a simple connection between the behavior of individual members within either the *n*-paraffin or olefin series and between the two series as a whole. The behavior of acetylene is related in a simple manner to that of ethylene and ethane, and a connection is apparent between the behavior of benzene and that of *n*-paraffins and olefins. The relationships do not extend to alkyl substituents in benzene, which have a disproportionately large effect in increasing the carbon-forming tendency of the flames.

A Contribution to the Theory of Laminar Flames with Radial Symmetry. J. Menkes. *Combustion and Flame 4*, 1 (1960) March (7 pp.)

Differential equations of motion of a flame with radial symmetry are transformed into an integral equation. The integral equation is solved numerically by a method of successive approximations. The dependence of the mass flow per unit area on the flame thickness and flame radius as well as on the temperature of the unreacted gas is investigated. It is demonstrated that the rate of change of the mass flow is determined by any two of the three parameters. The results of the calculations are presented graphically. The implications of the findings for the stability of combustion waves are discussed.

The Effect of Pressure on the Mechanism and Speed of the Hydrazine Decomposition Flame. G. K. Adams and G. B. Cook. *Combustion and Flame 4*, 9 (1960) March (10 pp.)

The hydrazine decomposition flame reaction is approximated by a simple one-center chain reaction with the termination step second order in radical concentration. The differential equations of flame propagation for this reaction scheme are solved by an unsteady-state method programmed for a high-speed digital computer. The results presented are the radical concentration/temperature distributions and space integral reaction rates (proportional to flame speed) for a range of final flame temperatures and pressures.

On Errors Committed in Flame Temperature Measurements in Flow Using Thermocouples. *Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk*, 137 (1957) Aug. (5 pp. Russian text); [From *Appl. Mech. Rev. 13*, 212 (1960) March]

Using a turbulent flame of benzene-air at a flow rate of 50 m/sec, a variation in temperature of 150°-250°C was found at 700°C. This variation is explained by assuming a chemical reaction at the thermocouple junction. As a result it is recommended that an average or mid-point temperature be taken as the thermocouple is rotated through 180° in the gas stream.

J. H. Davidson, India

The Theory of Burning of Solid and Liquid Propellants. D. B. Spalding. *Combustion and Flame 4,* 59 (1960) March (18 pp.)

The Centroid Rule of laminar gas-flame is applied to a simple model of condensed-phase propellant combustion; the propellant is supposed to undergo successively a phase-changing reaction and a gaseous combustion reaction. Curves are presented enabling the rate of burning in the gaseous flame to be calculated as a function of the propellant surface temperature and the centroid of the reaction-rate function. These curves, combined with information about the process of phase change, enable surface temperature and burning rate to be determined. Normal diffusion is assumed in the gas phase. The effect of heat loss from the propellant surface is considered. It is shown that this can lead, under some circumstances, to the existence of both lower and upper limits to the pressure under which stable burning is possible.

The Theory of Steady Laminar Spherical Flame Propagation: Equations and Numerical Solution. D. B. Spalding. *Combustion and Flame 4,* 51 (1960) March (8 pp.)

A combustible gas is supposed to emerge steadily from a point source immersed in an atmosphere of adiabatic combustion products. The differential energy equation is solved numerically, and it is shown that the effective radius of the spherical flame is larger than that predicted from the assumptions that the flame is very thin and that it has the same burning rate per unit area as a plane flame. The error increases as the rate of injection and the laminar flame speed of the mixture decrease. The thermal conductivity of the gas is assumed constant in the numerical analysis, but it is shown how the resulting data can be used in cases for which conductivity depends on the temperature.

The Use of Reversed Diffusion Flames for the Production of Acetylene and Ethylene from Paraffin Hydrocarbons. J. R. Arthur and D. H. Napier. *Combustion and Flame 4,* 19 (1960) March (10 pp.)

Advantages of reversed flames for the preparation of unsaturated hydrocarbons from paraffins are that 1) the products from the flame pass into a cold, non-oxidizing gas, and 2) geometrical arrangement of fuel and oxygen favors incompletely burnt products. The influence of the paraffin used, preheat of the gases fed to the burner, ratio of linear velocity of fuel and oxygen, oxygen enrichment, use of steam as diluent, and other variables on the yield of acetylene and ethylene were examined. Carbon monoxide and hydrogen were also formed in considerable quantity. From a propane flame, products containing up to 7% acetylene and 14.5% ethylene were obtained. The main factors determining the quantities of unsaturated hydrocarbons sampled are discussed.

Heat Treating

Symposium on "The Uses of Liquefied Petroleum Gases." Controlled Atmospheres Produced with Liquefied Petroleum Gases. J. S. Wilding and A. G. Turner. *J. Inst. Fuel 33,* 135 (1960) March (4 pp.)

Liquefied petroleum gases are now established as raw materials for the production of controlled atmospheres, and article deals with their use in this field. The production of exothermic and endothermic atmosphere is described, their compositions discussed and shown to differ essentially in endothermic gas containing greater amounts of carbon monoxide and hydrogen. A range of gas compositions can be produced by each method.

Industrial Heating

Symposium on "The Uses of Liquefied Petroleum Gases." Liquefied Petroleum Gases: Brief Survey of the Present and Future Position, with Particular Reference to the U.K. R. F. Horner, P. C. Jarvis and A. G. Turner. *J. Inst. Fuel 33,* 111 (1960) March (5 pp.)

Composition and principal properties of LPG are described. After a brief outline of the historical pattern of market developments, some present fields of application are mentioned. Reference is made to the problems of supply and distribution, and article concludes with a commentary on LPG in the United Kingdom.

Symposium on "The Uses of Liquefied Peroleum Gases." Some Practical Technical Aspects of the Uses of LPG in Industry in France with Particular Reference to the Metallurgical and Ceramics Industries. J. P. Liotier. *J. Inst. Fuel 33,* 116 (1960) March (31 pp.)

Practical aspects of how propane may be applied in the metallurgical and ceramic industries are shown by the examination of various industrial applications in France. The possibilities of selling to industry a highly priced heat unit by making use of the quality and properties of propane, coupled with strict attention to specially developed utilization techniques are illustrated. The technical aspects of the use of LPG burners are also discussed.

Town Gas at the Mullard TV Tube and Valve Works. *Ind. Gas* (British) *23,* 14 (1960) March (6 pp.)

Article describes town gas utilization in television tube plant and valve works at Simonstone, England. Entire group of plants uses about 400 MMCF town gas annually.

LPG

Liquefied Petroleum Gases in the Gas Industry: Characteristics and Utilisation. *Gas Times 94,* 23 (1960) March (3 pp.)

Average properties, such as specific gravity, latent heat of vaporization, specific heat, flammability limits, sulfur

content, etc., are presented for commercial butane and propane. Author discusses British utilization of LPG for augmenting existing production during peak load and as a complete supply of gas.

Refrigeration

The Fuel and Ignition Systems of a Free-Piston Refrigerant Compressor. J. H. McNinch, D. G. Mark and R. J. McCrory. (New York: Soc. Automotive Eng., Inc., 1960.) 10 pp.

Although considerable development remains prior to achieving fully satisfactory fuel and ignition systems, the experience to date shows that the approaches outlined in paper are well suited for a free-piston engine of the type described. Each meets the specific functional requirements with a high degree of simplicity and inherent reliability. Most of the remaining work will be directed toward obtaining the reliability and durability required for air-conditioning service. When completed, the free-piston compressor should be a major contribution to the increased usefulness of the internal-combustion engine.

Space Heating

Literature Pertaining to the Art and Science of Oil Burning for Residential Applications. C. F. Speich and D. W. Locklin. API Publication No. 1537. New York: Amer. Petrol. Inst., Jan. 1960 (112 pp.)

Review of technical literature and compilation of abstracts was prepared as a guide to references for research investigators and designers in the field of oil-burning equipment, and relates particularly to distillate fuel-oil combustion for residential heating equipment and similar low-capacity oil-fired applications. A total of 390 abstracts are given in the following fields: 1) atomization, 2) ignition, 3) physics and chemistry of combustion, 4) fuel-air mixing and recirculation, 5) flammability and stability limits, 6) catalytic and surface combustion, 7) combustion and equipment noise, 8) fuel-oil characteristics, 9) chimneys, vents, and combustion air supply, 10) laboratory and field performance studies, 11) combustion research techniques, 12) fuel-oil applications and equipment developments, 13) incinerators, and 14) codes and standards.

Water Heating

Domestic Solar Water Heater. K. N. Mathur, M. L. Khanna, T. N. Davey, and S. P. Suri. *J. Sci. Ind. Res., India 18A,* 51 (1959) Feb. (8 pp.); [From *Appl. Mech. Rev. 13,* 207 (1960) March]

An arrangement for heating water with solar energy for supplying the domestic needs of a small family at Delhi, using inexpensive construction materials is described. The heat collector unit consists of a wooden box, insulated at the bottom, in which are formed the flow channels for water by one corrugated and one plane galvanized iron sheet. The upper side is glazed with thick window glass sheets to reduce heat losses, with a two-inch gap between the glass sheets and the water flow channels. As the length of the day is short and water requirements large during the winter, the heating unit is set up at an angle of 45° to the horizontal to make the best use of sunlight. Flow rates of water, through the collector unit, in the range 4-21 gal/hr have been used and a rate of 7-10 gal/hr has been found to be optimum. Efficiency of heat transfer on a clear day is about 70%, which is more than that for the usual types of heat collector units using copper pipes soldered to flat copper sheets.

From author's summary

10. EQUIPMENT AND INSTRUMENTATION

Absorbers

A Design Technique for Cold Absorbers. C. S. Faulkner and I. Albiol. *Refining Eng. 32,* C-39 (1960) April (6 pp.)

Technique is presented for estimating the performance of a main stream absorber in which the temperature rise inside the absorber is minimized by use of an external controlled temperature contact between the absorber residue gas and the denuded lean oil. Contact is accomplished by passing the absorber overhead residue gas and lean oil concurrently through a heat exchanger whereby the mixture is cooled to some lower temperature than the average absorber temperature. From this cooling and contact step, the oil-gas mixture is passed to a flash drum from which the final residue gas is removed overhead and the saturated lean oil is pumped to the top tray of the absorber. Technique outlined determines lean oil rate and the amount of absorption of the components in the rich gas in such an arrangement and is demonstrated by the use of a sample problem.

Automation

Automatic Control with High-Speed Chromatography. M. M. Fourroux, F. W. Karasek, and R. E. Wightman. *Oil Gas J. 58,* 96 (1960) March 21 (4 pp.)

A new high-speed chromatographic analyzer, designed specifically for process control, has operated successfully in commercial closed-loop control systems. The analyzer has improved control substantially on a natural-gas-liquids depropanizer and also on a furfural absorber. Automatic chromatographic control of these columns saves utilities by permitting the operator to drive the column only as hard as necessary to maintain minimum product specifications.

Computers

Can Computers Control Your Process? C. R. Hall. *Chem. Eng. 67,* 153 (1960) March 21 (4 pp.)

For those who are examining systems for improvement through computer control, article recommends: 1) seek lower cost alternative solutions every step of the way; 2) have a strong mathematician or statistician on the team; 3) seek situations where there are uncontrollable

independent variables, which change fairly rapidly with time, and where there are two or more controllable independent variables; and 4) look for effects of interaction between independent variables upon results desired.

Natural Gasoline Plant Investment and Profitability. W. A. Fling, Jr. *Refining Eng. 32,* C-34 (1960) April (3 pp.)

New program for computer gives a fast, accurate method for "quickie" estimates of possible plant ventures or plant expansion. If preliminary evaluation indicates a worthwhile project, program is expanded to give the necessary information for a more precise detailed investment economics picture.

Soviet Computer Technology—1959. W. H. Ware, Ed. *ACM Comm. 3,* 131 (1960) March (36 pp.)

Factual account of the trip of the U.S. technical delegation in computers to the Soviet Union is described. It includes the itinerary, descriptions of specific Soviet computers and computing centers, a discussion of Soviet computer-oriented educations, and a description of current circuit and component development. The appendices, the first of which is included with the article, give the instruction repertoire of the Ural-I and the Ural-II machines, and an analysis of some magnetic cores. A bibliography of relevant Soviet documents is included.

Furnaces

Design of Laboratory Furnaces. P. L. Start and M. W. Thring. *J. Sci. Instruments 37,* 17 (1960) Jan. (8 pp.)

Paper illustrates the use of a heat balance in the design of small furnaces, and then discusses the principles of arc, arc-image, induction, electron-bombardment, resistor-heated and gas-fired furnaces. Constructional details are mentioned briefly with each type of furnace considered. A comprehensive table of resistor elements, refractory tubes, and insulating materials and their properties is included. Methods of controlling small furnaces are discussed in the final section.

Generators

Installation and Operation of Gas Atmosphere Generators. E. C. Bayer. *Ind. Heating 27,* 517 (1960) March (7 pp.)

Equipment and practice for attaining safety and controlled chemistry in exothermic and endothermic atmosphere generator operation is described.

Instruments

Rate Instruments for Maintenance. A. T. Sherman. *Chem. Eng. 67,* 178 (1960) March 21 (4 pp.)

Instrument maintenance costs are increasing at a greater rate than instrument investment. Major reason is the use of scanner-loggers, analyzers, computers, and other new types of electronic instrumentation for which previous maintenance experience is limited. Decreased costs for maintenance must come from improvements through better design of equipment. Author presents four graphs which correlate the principal factors—design, electrical characteristics, maintenance, and component quality—for maintenance evaluation of proposed equipment.

Metering

Bellows-Type Orifice Meters. W. S. Christian. *Instruments and Control Systems 33,* 466 (1960) March (4 pp.)

Although bellows-type flowmeters are being used in thousands of conventional flowmetering situations, the following uses show the special applications of flowmeter described: 1) ability to be over-ranged, 2) stainless-steel and mercury-free construction, 3) self-draining and self-venting feature, 4) no need for "leg of liquid" correction, 5) ability to handle high-pressure fluids, and 6) relative insensitivity to vibration and pulsation effects.

Process Equipment

What Are the Effects of Data Selections on Process Equipment? M. Stocking, J. H. Erbar and R. N. Maddox. *Refining Eng. 32,* C-15 (1960) April (4 pp.)

In order to evaluate effects of data selection on process equipment, data from several sources were used in different solutions of the same process problem. A distillation column was chosen as a basic example because rigorous plate-to-plate solutions can easily be made on a digital computer. For each problem input data remained the same except for a variation in either equilibrium or enthalpy data. Method of calculation used was that outlined by two of the authors previously. All calculations were carried out on a medium-sized computer. Data presented show that the choice of enthalpy and equilibrium data can have an appreciable effect on the distillation column design that results from process calculations.

What Makes This Plant Different? B. L. Short. *Refining Eng. 32,* C-26 (1960) April (5 pp.)

A new natural gasoline plant has been built at Laverne, Okla., near the western edge of Harper County. New design features plus the modification or reapplication of many proven features make it a standout as a new and different plant. New design features include: 1) gas-fired turbines driving electrical generators; 2) direct-fired process heater taking its combustion air from the exhaust of the gas turbine; 3) central control and instrument center; 4) split deethanizer and reabsorber; and 5) quality control within the plant maintained by a chromatograph.

Reactors

A Guide to Controlling Continuous-Flow Chemical Reactors. O. A. Solheim. *Control Eng. 7,* 107 (1960) April (8 pp.)

Reactor control first requires the development of transfer functions characterizing the single stirred-tank reactors carrying out a first order, isothermal, irreversible reaction. In particular, control synthesis is then

studied by practical, numerical application of transfer functions relating product concentration to inlet reactant concentration and reactant flow. To facilitate the comparison of alternate control schemes, the author employs the interesting concepts of the relative transfer function and the deviation-ratio curve.

Temperature Measurement

Some Notes on the Use of Resistance Thermometers for the Measurement of Heat Transfer Rates in Shock Tubes. B. D. Henshall and D. L. Schultz. *Aero. Res. Counc. Lond. Curr. Pap. 408,* 1959 (22 pp); [From *Appl. Mech. Rev. 13,* 203 (1960) March.]

A brief description is given of the model calibration technique and the experimental data reduction employed at the N.P.L. in the determination of heat-transfer rates in a hypersonic shock tube. Estimates are made of probable accuracy of such measurements, and specimen calculations and results are given.

From author's summary

A Thermocouple System for Measuring Turbine-Inlet Temperatures. M. E. Inhat and W. C. Hagel. *J. Basic Eng. 82,* 81 (1960) March (6 pp.)

Fast-response, unique thermoelement combination of platinum-15% iridium and palladium, whose emf output is about three-fourths that of Chromel/Alumel at 2000° F has been found reliable from 1800°-2300°F for more than 400 hr in a combustion atmosphere. A new, stable nickel-4.3% silicon matching-lead-wire alloy was prepared for use up to an ambient temperature of 1400°F. Additional tests provided the best choice of insulation, thermocouple dimensions, sheath material, connectors, and harness design for aircraft jet engines. While it has been previously impractical or very difficult to determine the turbine-inlet temperatures above 1600°F, this system is capable of measuring directly the most critical of all operational variables and accordingly allows safe potential increases in engine performance.

Two Thermocouples Suitable for Measurement of Temperatures up to 2800°C. D. A. Davies. *J. Sci. Instruments 37,* 15 (1960) Jan. (3 pp.)

The thermoelectric characteristics of two high-temperature thermocouples of tungsten/26% rhenium-tungsten and tantalum/26% rhenium-tungsten are described, and a method of determining the emf of the couples up to a temperature of 2800°C is given. In the temperature range 1000-2000°C, the sensitivity of the tungsten/rhenium-tungsten couple is 16.2 μ v/°C and that of the tantalum/rhenium-tungsten couple is 13.6 μ v/°C. The important feature of these thermocouples is their suitability for operation at much higher temperatures than existing couples, combined with a fairly high sensitivity.

Valves

Pressure Closure Valve. R. Henze, P. Rudolph, and F. Danulat (assigned to Metallgesellschaft A.G., Germany) U.S. 2,925,334 (1960) Feb. 16.

A pressure-closure valve is claimed as an inlet or outlet valve for a gas generator which is provided with charging locks. Improvement comprises a vertical passage way for gravity flow of materials. A rigid annular seat coaxially surrounds the passage, together with an elastic sealing ring, with seat and ring clear of the flow. When closure member is advanced, it first closes the flow passage and then seats firmly on the unobstructed seat and ring.

11. MATERIALS OF CONSTRUCTION, AND CORROSION

Cathodic Protection

Distributed Ground Bed System for Cathodic Protection. A. F. Schmierer. *Pipe Line News 32,* 44 (1960) March (2 pp.)

Article discusses the cathodic protection of poorly coated 24-in. pipeline laid in 1930, with particular reference to low-resistance soil, alternate dry and wet soil conditions, in a region of the country where limestone strata are encountered. In one such area it was found, in the beginning cathodic operations, that protection was achieved, but after two or three years protection became inadequate. It became necessary to meet the increased current demand by installing additional rectifier units. While this condition is not representative of all sections of older pipelines, it is fairly common.

Hot Weather Affects Cathodic Protection of Pipe Lines. F. E. Costanzo. *Pipe Line Ind. 12,* 32 (1960) March (6 pp.)

Whether it is cold or hot makes little difference in the current required to protect a pipeline. However, rainfall and to a degree, snow, do affect the requirements. In a test conducted in Pennsylvania, where a bare line was under 30 in. of cover, it took a ½-in. rain to affect the requirements. Maximum effect came from a 1.5-in. rain. Additional rain had little added effect. Weather-bacterial effects were also studied.

Old Abandoned Pipe Line May Be a Source of Corrosion Trouble. J. Emery. *Pipe Line Ind. 12,* 45 (1960) March (2 pp.)

When a particular area of pipeline requires excessive current for no obvious reason, an old abandoned pipeline may be the source of difficulty. Pipe-to-soil potentials are shown before and after a contact with an old abandoned line was removed. Before the old line was discovered, corrosion engineers had trouble explaining the variation in instrument readings which sometimes occurred hourly. Removal of two joints of the old pipe eliminated the contact and permitted a decrease in the output of the rectifier.

Protection of Gas Service Lines in Non-Stray Current Areas. P. P. Skule. *Am. Gas J. 187,* 22 (1960) March (4 pp.)

Article gives four rules for protection of gas service lines in nonstray current areas: 1) an insulator should

be installed at or near the meter end to disassociate the steel gas service from neutral grounds, house piping, and water service lines; 2) an insulator should be installed at the juncture of the service line with the company's property where the service is to be cathodically protected, or where the main is to be protected and not the services; 3) insulators should be checked for effective installation; and 4) individual bare steel and coated steel services are easily protected with anodes if the service line is insulated at its extremities.

Thermoelectric Cathodic Protection. E. Tornquist. *Am. Gas J. 187,* 20 (1960) March (2 pp.)

Northern Illinois Gas has installed a gas-fired ten-watt thermoelectric generator unit that will provide current for cathodic protection of gas mains. Cathodic protection procedures require a low voltage direct-current. Use of a thermoelectric type generator, therefore, would have value in many cases as its output is d-c in the desired voltage range. When applied to gas mains, the energy for its operation is always present.

Titanium-Platinum Electrodes for Cathodic Protection in Sea-Water. G. Bombara and D. Gherardi. *Metallurgia Italiana 51,* 462 (1959) Oct. (5 pp. Italian text); from *Eng. Digest 21,* 81 (1960) Feb. (2 pp.)

Extensive use is being made of platinum-faced titanium as a sacrificial-anode material for cathodic protection in sea water or in other solutions containing chlorides without, however, having detailed knowledge of its electrochemical behavior. Paper presents research done to obtain full data on the anodic properties (weight losses and potentials as functions of current density) of titanium and platinum anodes, separately and in pairs, and also of titanium-platinum bimetal anodes and platinum-plated titanium anodes. It was found that the addition of platinum gives an anodic protection which is up to ten times greater than that obtainable with titanium alone. Durability depends on the type of platinum plating process used.

Coatings

Bacterial Activity at the Bottom of Back-Filled Pipe Line Ditches. J. O. Harris. *Corrosion 16,* 149t (1960) March (6 pp.)

Bacterial activity at the bottom of backfilled pipeline ditches was compared with that found in normal undisturbed soil. Topics discussed include the effect on bacterial development of: availability of food materials in soil, water availability in soils, effect of oxygen content of soil, soil acidity, temperature variations, application of cathodic protection, compaction and settling of backfill. A study was made of the role bacteria play in the deterioration of pipeline coatings. The significance of high moisture in soil adjacent to the lines, the moisture content of coatings and the presence of aerobic bacteria near the pipelines was discussed.

Interior Surface Coating of Pipe for Natural Gas Service. G. G. Wilson, Institute of Gas Technology Tech. Rep. No. 3 New York: American Gas Association, Feb. 1959, $2.00 (76 pp.)

A literature and industry survey of oil and gas industry experience with internally coated pipe, methods used to apply internal pipe coatings, and a laboratory screening evaluation of coating materials suitable for the internal coating of pipe for natural gas service.

New Surfacing Methods Vie with Old. J. R. Schley. *Chem. Eng. 67,* 184 (1960) March 21 (4 pp.)

Article reviews six surfacing processes for high-temperature applications; flame plating, diffusion coating, hot-dip, metallizing, hard-facing, and cladding and strip lining.

Pipe-Treating Apparatus. L. F. McBride (assigned to C. W. Fuelling.) U.S. 2,928,357 (1960) March 15.

An internal coating apparatus for buried pipelines is designed to detect pipe-joints, lock itself on the joint and to force plastic sealing material into the circumferential cavity of the joint by means of rotating paddles. The device, which moves along the inside of the pipe, comprises a carriage structure with wheels on the opposite lower sides of the supporting structure. The wheels are canted to the longitudinal axis, and a pressure-activated bar cants each set of wheels to the sides in the opposite positions to avoid upsetting the machine during travel.

Pipe Lining Troweling Apparatus. W. E. Perkins. (assigned to Perkins Pipe Linings, Inc.) U.S. 2,924,867 (1960) Feb. 16.

A troweling device is claimed for following the moving coating applicator apparatus and exerting radial pressure to seat, consolidate and smooth the coating. This device is a conical shell of thin resilient, hard-surfaced sheet, bent to conical shape at the leading end, with pivoted lapped edges constrained transversely to exert a yieldable adjustable perimeter-enlarging force on the trailing (troweling) end of the cone.

Plastic Pressure-Sensitive Tapes as Pipe Coating Materials. *Am. Gas J. 187,* 26 (1960) March (9 pp.)

Plastics, such as polyethylene and polyvinyl chloride, have electrical, physical, and chemical qualities for pipe coating that compare favorably with competitive materials. In some cases, applied costs of plastic tape pipe coatings are competitive with, or less than, equivalent conventional materials. Upward trend of both labor and material costs is in a direction favoring plastic tapes. Application of tape coatings, compared with hot applied materials, is simpler, requires less skill, less manpower, and less equipment, and is a safer operation. Plastic tapes are being used under a wide range of terrain and weather conditions on a variety of piping systems, ranging from gas service lines to major large-diameter gas transmission pipelines. Utilization of pressure-sensitive adhesives has made it possible for plastic tapes to be developed into acceptable pipe coatings. Tape manufacturers must select those that will remain stable over a long period of time when subjected to the various conditions to which pipe is exposed.

Testing of Protective Coatings for Metals. W. E. Kirkendall. Part 1. *Corrosion Tech. 7,* 41 (1960) Feb. (5 pp.); Part 2. *Ibid.,* 88 (1960) March (5 pp.)

Article gives details of author's work in establishing a

research and testing program for use in selection of protective coatings for metals and methods for their application. It is intended primarily for use by the waterworks and public utilities industries and aircraft manufacturing industries. Part 1 deals with the principles and practice of the newly developed indicator solution and electrolytic conductance tests on protective coatings for steel pipe. Practical methods and procedures for obtaining and recording laboratory test data on the performance of protective coatings and of plastic tape-wrap coatings applied to steel pipe as primary protection against corrosion are discussed in Part 2.

Corrosion

Kinetics of Absorption by Metals of Hydrogen from Water and Aqueous Solutions. T. G. O. Berg. *Corrosion 16,* 198t (1960) April (3 pp.)

The kinetics of absorption of hydrogen in corrosion is treated on the basis of a mechanism previously proposed for the absorption of hydrogen from H_2 gas. Rate formulae are derived and compared with experimental data. On certain simple assumptions, a parabolic or a cubic rate law is derived for an initial period, during which absorption of hydrogen occurs. This rate law is succeeded by a linear rate law when the metal is saturated with hydrogen. The rate in acid solutions is proportional to the square root or the cube root of the acid concentration. The rate in water vapor is proportional to the square root of the water vapor pressure or independent of the water vapor pressure.

Relationship of Microstructure and Stress Corrosion Cracking of Type 410 Stainless Steel. P. S. Trozzo and R. F. McCartney. *Corrosion 16,* 26 (1960) March (4 pp.)

Three heats of AISI Type 410 stainless steel that exhibited different degrees of susceptibility to stress corrosion fracture in pure-water environments were investigated by electron microscopy and diffraction techniques to correlate microstructure with stress corrosion fracture behavior. In the hardened condition and tempered at 650°F, these steels cracked at stresses as low as 40,000 psi along networks of essentially untempered martensite in the prior austenite grain boundaries. Tempering at a temperature (1175°F) high enough to break up the continuous network in the prior austenite grain boundaries reduced stress corrosion, but at the expense of a reduction in tensile properties.

Inhibitors

Corrosion Inhibitor Evaluation at Elevated Temperatures. V. W. Maxwell. *Corrosion 15,* 201t (1960) April (4 pp.)

Evaluation of commercially available, organic corrosion inhibitors at elevated temperatures is presented. All of these inhibitors were designed for down-the-hole treatment of producing oil and gas wells. The evaluations at elevated temperatures were compared to the evaluations of the same inhibitors run at room temperature. All phases of the test used are discussed, including apparatus, materials used, and test method. A table of results is given, as well as a block graph showing the average percent protection obtained for each inhibitor at the temperatures tested.

Oil-Soluble Inhibitors for Controlling Corrosion in Tankers and Pipe Lines. W. S. Quimby. *Corrosion 16,* 9 (1960) March (6 pp.)

A discussion is presented of causes of corrosion in the transportation and refining fields of petroleum industry where oil-soluble inhibitors can be used. Requirements of a good inhibitor are listed, and a case history of use of inhibitors in one pipeline is given. Refinery application of inhibitors is discussed briefly, also use of inhibitors in tanker ships carrying clean oil cargoes. Vapor space corrosion in tank ships is controlled by application of inhibitors by brush, flotation and fogging. Tests are discussed in which inhibitors were added to crude oil carried in tankers to control corrosion.

Rust Inhibition Through Calcium Plumbate Pigment. H. C. Wesson. *Corrosion Tech. 7,* 37 (1960) Feb. (2 pp.)

Calcium plumbate pigment, used to coat steel surfaces, has been commercially available since 1950. Article outlines its characteristics and advantages. Although the exact mechanism of its protective power is not clear, in a priming paint, it protects the steel by suppression of both the anodic and cathodic areas of the structure. When calcium plumbate is added to linseed oil paint and the combination used to coat steel, there is none of the usual blistering and softening that usually occurs when exposed to sea water.

Metals

Which Metals for High Temperature Structures? V. D. Varth and H. R. Ogden. Reprint by Battelle Memorial Inst. (From *Space/Aeronautics,* (1960) Jan.) 4 pp.

As the requirements of high-temperature aerospace structures increase, so does the variety of metals and alloys suggested to meet them. Article describes the many promising metallic high-temperature materials that have appeared recently, and points out where and how they can best be used.

Plastics

Plastics Developments. L. W. Brock. *Mech. Eng. 82,* 65 (1960) March (9 pp.)

Author presents a 329-reference review of the plastics development literature for 1958-59. Articles and papers on materials, engineering properties, processing, products, and the future outlook for the plastic industry are itemized.

12. ANALYTICAL METHODS AND TESTS

Carbon

Determination of Carbon and Hydrogen Content of Solid Fuels. W. Radmacher and A. Hoverath. *Brennstoff-Chemie 41,* 52 (1960) Feb. 17 (3 pp. German text)

As an alternate to the Macro-Sheffield-High Temperature method, a semimicromethod of determining carbon and hydrogen content of solid fuels was developed which has many advantages over the Sheffield and standard methods. New method is not affected by degree of coalification or ash content of same and is readily applied to a broad range of sulfur, carbonates or volatile matter. It is simpler and faster and thus quite useful in series studies. The operation requires 25 min, renewal of absorption chemicals suffices for 40 determinations, and the tube packing lasts for 150 tests and is regenerated in place.

Coal

The Distribution of Hydrogen in Coals and Its Relation to Coal Structure. P. H. Given. *Fuel 125,* 147 (1960) March (7 pp.)

Estimates of the ratio $C—H_{ar}/C—H_{al}$ obtained by methods of infrared and proton magnetic resonance spectroscopy are examined. The ratio is important because if the estimated values are correct, the number of types of structure that can be assigned to the vitrinites of bituminous coals is severely limited. A number of possible molecular models are considered. It is shown that polymeric structures in which the hydrocarbon skeleton of the monomer is of the type 9:10—dihydroanthracene with methylene group linkages can have the correct analysis for typical vitrinites and also have hydrogen ratios equal to or slightly higher than those estimated by Brown by infrared spectroscopic methods. A model structure is shown to illustrate one way in which such monomer units can be linked together and substituted with oxygen groups. The probable properties of the model are compared with those observed for vitrinites, and it is concluded that in several respects they correspond reasonably well.

Coal Tar

A Note on Determining the Arrangement of Rings in the Polynuclear Aromatic Compounds of Coal Tar Pitch Formations. C. Karr, Jr. *Fuel 39,* 119 (1960) March (5 pp.)

A mathematical treatment of ring index (total rings per carbon atom, R/C) vs. atomic hydrogen to carbon ratio (H/C) is present for several common series of condensed polynuclear aromatic compounds. It is shown that each series has a different set of expressions of R/C and H/C in terms of R, from which the arrangement of rings can be differentiated for compounds containing less than ten rings.

Chromatography

The Correlation of Separating Power and Efficiency of Gas-Chromatographic Columns. J. H. Purnell. *J. Chem. Soc.,* 1268 (1960) March (7 pp.)

A new measure of gas-chromatographic column efficiency, the separation factor *S*, is proposed and defined. Methods of calculating its value, both empirically from elution curves and from relative volatility data, are described. A general equation relating theoretical-plate requirements with relative volatility data are described. A general equation relating theoretical-plate requirements with relative volatility, retention volume, and free space in the column is derived. This equation is used to explain inconsistencies in the apparent separating power of different columns, in particular, for capillary and packed columns. Application of the equation to prediction of experimental efficiency requirements, with consequent elimination of much experimental work, is discussed.

Gas Chromatography. S. Dal Nogare. *Anal. Chem. 32,* 19R (1960) April (7 pp.)

Review is confined to the literature dealing with gas chromatography which has appeared subsequent to the review of Hardy and Pollard [J. Chromatog. 2, 1 (1959)]. The technique-centered aspects of these articles is considered mainly. Author points out that a comprehensive review covering both fundamental and applied aspects would approximately double the amount of literature cited. Under main topics of packed columns, capillary columns, detection, and specialized operation, a total of 244 literature references are presented.

Retention Temperature and Column Efficiency in Programmed Temperature Gas Chromatography. H. W. Habgood and W. E. Harris. *Anal. Chem. 32,* 450 (1960) April (4 pp.)

The relationship between r/F and retention temperature and retention volume is predicted from isothermal chromatographic measurements in programmed temperature gas chromatography. Retention temperature depends on the ratio of heating rate to carrier gas flow rate. Column efficiency may be calculated and an equation is established.

Some Aspects of Gas Chromatography. P. J. Farenden and M. P. Mendoza. *B.C.U.R.A. Monthly Bull. 23,* 366 (1959) Aug./Sept. (11 pp.)

Principles and devices for separations by gas chromatography are briefly reviewed. Applications in fuel gas analysis, air analysis, coal tar, phenol constitution, pyridine bases, and sulfur compounds are discussed from 127 recent references.

Dust

Correction for Anisokinetic Sampling of Gas-Borne Dust Particles. S. Badzioch. *J. Inst. Fuel 33,* 106 (1960) March (5 pp.)

A representative sample of dust can be obtained from a dust-laden gas stream only if sampling is isokinetic. An expression is given for the effect of anisokinetic sampling upon the relative quantity of dust entering the sampling nozzle. Two methods of calculating the dust concentration are considered and a criterion is provided for deciding, under the particular sampling conditions, which method gives the closer approximation to the true dust concentration. Procedures are given for

determining the true concentration and true size distribution of dust from a sample collected anisokinetically. Finally, sampling at a fixed velocity is considered. In the case of very fine or very coarse particles, the errors arising from sampling at a fixed velocity, irrespective of the value of the gas velocity, are small, providing the appropriate method of calculation is employed.

Gas Analysis

Extracting and Analyzing Gas from Well Drilling Mud. C. J. Engle and S. J. Marwill (assigned to Phillips Petrol. Co.) U.S. 2,923,151 (1960) Feb. 2.

Hydrocarbon gas is extracted and analyzed from well drilling mud for purposes of logging hydrocarbon occurrences in various strata penetrated. Mud directly from well is heated and water added and is directed tangentially into a conical hydraulic cyclone. A gas outlet is provided axially at top mud overflow, with vacuum pump to draw gas through drying and analyzing apparatus.

Gas Analysis. A. P. Hobbs. *Anal. Chem. 32,* 54R (1960) April (10 pp.)

Review covers the last two years of published articles on gas analysis. Even though new instrumentation has been introduced to do away with older methods of analysis, there have been large numbers of new and revised methods of analysis published. All the new developments, new methods, and new apparatus cannot be recorded because of the existing volume. Author has used his discretion in choosing a total of 300 references listed. Main headings include oxygen, ozone, nitrogen compounds, carbon dioxide, carbon monoxide, sulfur, mercury vapor, fluorine compounds, halogen compounds, acetylene, hydrocarbons, toxic and nerve gases, combustion, detector tubes, water, rare gases, gases in metals, specific gravity and density, heating value of gases, solubility, physical properties in analysis, acoustic analyzers, and sampling.

Proportional Sampling System for the Collection of an Integrated Auto Exhaust Gas Sample. J. C. Chipman and M. T. Massey. *J. Air Pollution Control Assoc. 10,* 60 (1960) Feb. (10 pp.)

The proportional sampling system was developed for the purpose of obtaining an integrated auto exhaust gas sample. The system was designed to accumulate continuously a constant percentage of the discharge gas from a vehicle under road operating conditions. Sampling rate varies simultaneously with the exhaust gas flow rate. This is accomplished by an electronic system consisting essentially of a strain gage pressure transducer, voltage amplifier and a power amplifier. Control signal to the system is obtained by the use of a viscous flowmeter which meters the air delivered to the carburetor system of a vehicle. Electronic and analytical evaluation studies indicate that the system is reliable within the desired overall accuracy of 90% and responds to the normal engine transient operating conditions throughout the test run.

Infrared Spectroscopy

Infrared Spectroscopy. R. C. Gore. *Anal. Chem. 32,* 238R (1960) April (3 pp.)

Practice of infrared spectroscopy has expanded tremendously during the past two years with the increased availability of instrumentation. Present review of literature references gives 96 current articles in the following fields: instrumentation and techniques; far- and near-infrared; kinetics, adsorption and surface chemistry; absorption intensities; solvent and polar effects; hydrogen bonding; polymers; and quantative and qualitative analyses.

Mass Spectrometer

Mass Spectrometry. V. H. Dibeler and R. M. Reese. *Anal. Chem. 32,* 211R (1960) April (11 pp.)

The increase in volume of literature on mass spectrometry continues at an accelerating pace. An attempt is made to give only representative samples of various applications published since late 1958. A total of 489 literature references present information on theory and design, instrumentation and techniques, ionization and dissociation processes and mass spectra, applications to chemical physics and physical chemistry, analytical applications, precise mass measurement and isotope abundance, and nuclear and geochemical topics.

Phenols

Countercurrent Distribution of High-Boiling Phenols from a Low-Temperature Coal Tar. C. Karr, Jr., P. A. Estep and L. L. Hirst, Jr. *Anal. Chem. 32,* 463 (1960) April (13 pp.)

Tar acids boiling at 231° - 331°C from low-temperature bituminous coal tar are fractionated and analyzed by distillation and countercurrent distribution. Of 84 compounds demonstrated, 24 were determined with respect to specific isomers and 36 on structure type. The remainder are unknown tar acids.

Porosity

Automatic Apparatus for Determination of Nitrogen Adsorption and Desorption Isotherms. E. V. Ballou and O. K. Doolen. *Anal. Chem. 32,* 532 (1960) April (5 pp.)

An apparatus is designed which automatically adds or removes constant volumes of nitrogen from an absorbent sample system. In studies of pore size distribution of small-pore materials, the apparatus affords a saving of time and recorded data on pressure-volume characteristics of the system.

Radioactivity Applications

Nucleonics. W. W. Meinke. *Anal. Chem. 32,* 104R, (1960) April (33 pp.)

Article reviews publications in nucleonics from late 1957 to late 1959. Papers appearing in this field no longer are restricted to major publications from a few countries. Wide diversity has necessitated ommission of a large number of references. However, a total of 1059

literature references have been compiled, and are classified in the following main subjects: nuclear data, radioisotope production, general biological, radioisotopes as sources, radioisotopes as tracers, instrumentation and measurement, safety and teaching.

Water

Determination of Water Content in Natural Gas. E. L. Upp and W. F. Barker. *Gas Age 125,* 23 (1960) March 3 (8 pp.)

A discussion is presented of moisture content determination equipment, with special emphasis on the electrolytic method, which the authors find accurate, reproducible and dependable. Electrical circuits, flow system, sample pressure and purge, calibration, accuracy, temperature effects, sample composition and speed of response for the electrolytic method are described.

13. BASIC SCIENCE

Adsorption

The Potential Theory of Adsorption of Gases and Vapors for Adsorbents with Energetically Nonuniform Surfaces. M. M. Dubinin. *Chem. Reviews 60,* 235 (1960) April (7 pp.)

Review surveys the results of experimental and theoretical investigations which have led to the development of the potential theory of adsorption, in which the determining role is played by dispersion forces. Views developed are applicable to the physical adsorption of gases and vapors on carbonaceous adsorbents that consist of a nonpolar substance—carbon. Characteristic adsorption equations were substantiated for structural types of carbonaceous adsorbents. Filled volumes of adsorption space and of the adsorption potentials for substances in gaseous and vapor states were calculated. Adsorption isotherms for gases and vapors were obtained for broad ranges of temperatures that include the critical region.

Catalysis

Chemisorption of Nitrogen on Iron Catalysts in Connection with Ammonia Synthesis. Part 1. The Kinetics of the Adsorption and Desorption of Nitrogen. J. J. F. Scholten, P. Zwietering, J. A. Konvalinka and J. H. de Boer. *Trans. Faraday Soc. 55,* 2166 (1959) Dec. (14 pp.). **Part 2. The Rate-Determining Step in Ammonia Synthesis.** J. J. F. Scholten, J. A. Konvalinka and P. Zwietering. *Ibid.,* 262 (1960) Feb. (7 pp.)

Extensive evaluation is presented in Part 1 on the gravimetric study of the adsorption and desorption kinetics of nitrogen on a singly-promoted iron catalyst with the rate of ammonia synthesis over the same sample. During synthesis the amount of nitrogen chemisorbed on the catalyst is determined gravimetrically. It is shown that the chemisorption and synthesis rates were equal at the same temperature, nitrogen pressure and nitrogen coverage. Kinetics are discussed in terms of the absolute reaction rate theory. Part 2 presents results showing that the nitrogen coverages calculated by means of the nitrogen fugacity and the chemisorption isotherm were in accordance with the coverages found gravimetrically. Results are in agreement with well-known supposition that nitrogen chemisorption is the rate-determining step in ammonia synthesis.

Gas Reactions

The Interactions Between Nitrogen and Oxygen Molecules. W. E. Meador, Jr. Washington: *Nat. Aero. Space Admin.,* Tech. Rep. R-68, 1960 (52 pp.)

Lippincott's delta-function model for atomic interactions is analyzed, both physically and mathematically, and extended, by differentiation between K- and L-shell electrons and the introduction of a variable parameter in the expression for the delta-function strength, to cover homonuclear molecules more complex than hydrogen. In addition, modifications are made which allow treatments of diatomic, heteronuclear molecules. This theory, in conjunction with a reasonably extensive study of resonance, dispersion, and configuration interaction phenomena, as well as the use of simple quantum mechanical arguments, is then applied to the N_2–N_2, N_2–O_2, and O_2–O_2 interactions.

Heat Transfer

Experimental Results of a Heat-Transfer Study from a Full-Scale Pebble-Bed Heater. R. B. Lancashire, E. A. Lezberg and J. F. Morris. NACA Tech. Note D-265. Washington: Nat. Aero Space Admin., March 1960, $0.75 (22 pp.)

Data were obtained from the initial operation of a large regenerative pebble-bed heat exchanger in order to determine the heat-transfer characteristics of a packed bed of spheres. Facility, designed to produce high-temperature air for hypersonic flight research, is described in detail. The heat-transfer analysis and results are presented and compared with those of other investigators.

Heavy Water

The Future for Cheap Heavy Water. F. T. Barr and W. P. Drews. *Chem. Eng. Progress 56,* 49 (1960) March (8 pp.)

Almost 100 ideas were considered in this study to find alternatives to existing methods for manufacture of heavy water. The following eight processes were found to have prospects for future economic development: 1) hydrogen/water exchange; 2) hydrogen/water-hydrazine; 3) phosphine water; 4) hydrogen iodide/water; 5) ammonia distillation; 6) reversible electrolysis of water; 7) direct electrolysis of deuterium; and 8) char adsorption of water.

Hydrogen

Process for the Recovery of Hydrogen Which Has Been Enriched in Deuterium. E. W. A. Becker. U.S. 2,927,003 (1960) March 1.

Process is claimed for recovering hydrogen enriched

with deuterium, in which streams of hydrogen and liquid water are passed countercurrently to each other. The water first is passed through a hot and cold column of a stripping cycle and then through a cold and hot column of a concentrating cycle. The hydrogen which leaves the latter hot column is enriched with deuterium, and one-third is withdrawn for further treatment. The remaining hydrogen comes to equilibrium (with respect to deuterium) with the water of the cold column, and its deuterium is returned to the hot concentrator whereupon the depleted hydrogen passes to the cold-hot stripper system. Platinized carbon can be added to water to catalyze the deuterium exchange.

Theory of the Infrared and Raman Spectra of Solid Parahydrogen. J. Van Kranendonk. *Can. J. Phys. 38,* 240 (1960) Feb. (22 pp.)

Theory of rotational and vibrational energy bands in solid hydrogen, developed previously, is applied to the interpretation of the infrared and Raman spectra of solid parahydrogen. A comparison of the theory with experimental results yields information about the nature of the rotational and vibrational motions of the molecules in the solid, and about the anisotropic intermolecular forces. A calculation of the intensity of the infrared rotational and vibrational lines is given, which is based on the induction mechanisms introduced previously to explain the induced absorption in gaseous hydrogen. Satisfactory agreement between other than nearest neighboring molecules, and of the interference effects affecting the single transitions is pointed out. A frequency analysis is given of the infrared and Raman rotational and vibrational lines in the solid, and a consistent theory of the shifts and splittings of the various lines is obtained. Empirical values of the rotational and vibrational coupling constants are derived and compared with the theoretical values.

Hydrogen Sulfide

Mechanism of the Iron-Hydrogen Sulfide Reaction at Elevated Temperatures. H. Arm, P. Delahay, C. Hudgins, F. Hugli, L. Hulett, and M. Qureshi. *J. Electrochemical Soc. 107,* 264 (1960) April (8 pp.)

Mechanism of the iron-hydrogen sulfide reaction was studied in the 500-700°C temperature range for a total gas pressure of one atm. The rate of attack was essentially constant (linear law), and the corrosion scale was composed of two layers: a thin dense layer adjacent to the metal and a porous layer with a coarse crystalline structure. These two features which differentiate this reaction from the iron-sulfur vapor reaction are interpreted on the basis of two main effects: 1) partial blocking of reaction sites by hydrogen produced during attack, and occurrence of a reaction at a constant number of reaction sites; and 2) continuous recrystallization of the dense scale into a porous scale offering no barrier to transport of reactants. This mechanism is self-regulating. Discussion of experimental methods covers the following points: a) measurements of the rate of attack with quartz spring balance in hydrogen-hydrogen sulfide and helium-hydrogen sulfide mixtures; b) techniques for attack in sulfur vapor followed by hydrogen sulfide attack; c) use of a mild steel cartridge containing lithium aluminum hydride in the hydrogen diffusion studies; and d) scale thickness studies.

Methane

Solubility of Methane in Water. J. E. Davis and J. J. McKetta. *Petrol. Refiner 39,* 205 (1960) March (2 pp.)

Most of the work on the solubility of methane in water has been conducted at either extremely high pressures or at atmospheric pressure. Investigation reported studies the solubility of methane in water at pressures to 500 psia at temperatures from 100-250°F.

Thermal Conductivity of Condensed Films: Methane. J. T. Clarke and R. Gorden, Jr. *J. Chem. Phys. 32,* 705 (1960) March (3 pp.)

New method of determining the thermal conductivity of condensed films at low temperature has been developed. It is based on determining the surface temperature of a film of known area and thickness by measuring its equilibrium vapor pressure. The thermal conductivity, k, of the film is calculated by measuring the increase in surface temperature as the film thickness is increased when a known heat flux is flowing across the film. For methane at 85°K, $k=3.5 \times 10^{-3}$w/cm−°K

Nitrogen

The Reactions of Active Nitrogen with Hydrogen Sulphide and Carbon Disulphide. R. A. Westbury and C. A. Winkler. *Can. J. Chem. 38,* 334 (1960) March (9 pp.)

Destruction of either H_2S or CS_2 by active N_2 appears to be minimal at some temperature in the range 200-250°C. Both reactions yield large amounts of polymer. It is postulated that the main reactions involve destruction of the reactant as it acts as a third body for recombinating of nitrogen atoms. As the temperature is increased, dissociation of the nitrogen atom — reactant complex apparently increases. To account for the observed temperature effects, it is assumed that reactions also occur to regenerate reactant.

Radioactivity Applications

Effects of Ethylene, Hydrogen and Radiation Dosage on the Tritiated Products Resulting from the He^3 (n,p)H^3 Reaction in Gaseous Hydrocarbons. M. C. Sauer, Jr. and J. E. Willard. *J. Phys. Chem. 64,* 359 (1960) March (4 pp.)

Yields of HT, and of the tritiated hydrocarbons through C_8 produced by the neutron irradiation of mixtures of He^3 with methane, ethane and propane, have been determined in the presence and absence of added ethylene and of hydrogen, and under different intensities of ionizing radiation. The results indicate that the thermal tritium atoms are effectively scavenged by ethylene with a resultant increase in the yield of tritiated butane and other products which may be formed by combination of C_2H_4T radicals with other radicals. Added H_2 increases the yield of HT and decreases that of tritiated chain lengthened products. Tests have been conducted of the effects of radiation intensity and dose.

Refrigeration

Physical Aspects of the Research on Gas Refrigerating Machines. J. W. L. Kohler. *Ingenieru 70,* 49, w. 175-w. 178, (1958) Dec. (Dutch text); [From *Appl. Mech. Rev. 13,* 203 (1960) March.]

Many problems linked with the Stirling process prove to be of a rather fundamental nature. The reason is that, whereas normal refrigerating apparatus consists of rather isolated equipment connected in series, the Stirling process is performed in a single machine, which combines all functions; this gives rise to a number of difficult cross effects. Some examples of this are given; for instance, the regenerator which is the most interesting, but difficult, element of the machine. The cycle is interesting as a fine illustration of a reversible cycle; the results of its study may be used on a broad front, i.e. also for the hot gas engine, the cold gas engine and the heat pump.

From author's summary

Sulfur

The Vapour Pressures and Latent Heats of Sublimation of α-, β-, and γ-Sulphur. C. Briske, N. H. Hartshorne, and D. R. Stranks. *J. Chem. Soc.,* 1200 (1960) March (10 pp.)

The temperature coefficients of the rates of effusion of sulfur vapor in equilibrium with 1) α- and β-sulfur over the range 0-60°C, and 2) γ-sulfur over the range 0-40°C, have been determined by a radiochemical method. Corresponding latent heats of sublimation [cal. mole/(S_8)] and their 95% limits are: α 23,850 $\pm$ 130; β 23,060 $\pm$ 170; γ 23,110 $\pm$ 180. An approximate determination of the relation between the activities of the effusates and their weights was also made, and values of the vapor pressure of α-sulfur calculated from this agree within experimental error with those of previous workers. Effects on the results of allowing for possible partial dissociation of the vapor are discussed, and it is shown that degrees of dissociation consistent with those recently reported for higher temperatures have very small effects.

Thermal Conductivity

Electrical Determination of the Thermal Parameters of Semiconducting Thermoelements. *J. Appl. Phys.* (British) *10,* 235 (1959) May (2 pp.); [From *Appl. Mech. Rev. 13,* 203 (1960) March.]

Thermal conductivity, thermal capacity and electrical conductivity can be deduced from the observation of the time dependence of the electrical potential difference across a sample due to its own thermoelectric force. The mean temperature of the semiconductor must be measured. The Seebeck cofficient should be determined in a separate experiment.

W. L. Sibbitt, USA

A Theoretical Analysis of the Method of Measuring Thermal Conductivity of Semiconductors Proposed by A. V. Ioffe and A. F. Ioffe. M. A. Kaganov. *Soviet Phys.-Tech. Phys. 3,* 2169 (1959) June (4 pp.). Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR 28,* 2364 (1958) Nov. (5 pp. Russian text) by Amer. Inst. Phys., Inc. New York, N. Y.; [From *Appl. Mech. Rev. 13,* 204 (1960) March.]

From the equation for the temperature distribution along the sample, author deduces the time interval after beginning of the experiment during which the calculation of the thermal conductivity can proceed by the method. Further, he states corrections which must be introduced into the basic formula to take into account the heat losses to the surrounding medium.

F. Krupka, Czechoslovakia

Thermodynamics

Nitrogen at High Temperatures. AFOSR TN 59-264 (General Electric Co., Flight Propulsion Lab. Dept.; ASTIA AD 212 467) 1959 (52 pp.); [From *Appl. Mech. Rev. 13,* 203 (1960) March.]

The basic thermodynamic properties of pure nitrogen at high temperatures are presented. Internal energy, enthalpy, entropy, electron density, and electrical conductivity are given in engineering units for the temperature range from 5000 to 30,000 K, and pressures varying from 0.2 to 100 atm. The temperature and pressure dependency of dissociation and ionization are also shown. All calculations are based on statistical thermodynamics.

From author's summary

Tables of Thermodynamic Functions of Air. A. S. Predvoditelev, E. V. Studochenko, E. V. Samuilov, I. P. Stakhanov, A. S. Pleshanov, and I. B. Rozhdestvenskii. London: Infosearch, Ltd., 1958 (301 pp. translated from Russian); [From *Appl. Mech. Rev. 13,* 202 (1960) March.]

This volume forms one of a series of tables covering the range 1000° to 20,000°K. The following properties are each listed to four significant places: internal energy, enthalpy, entropy, specific heat at constant volume and at constant pressure, the ratio of specific heats, velocity of sound, density, molecular weight, and 13 molar fractions of the constituents of air.

From preface

Ultrasonics

Simple Magnetosonic Waves. *Ukrain. Fiz. Zh. 3,* 567 (1958) No. 5 (4 pp. Ukrainian text). Translated by Morris D. Friedman, Inc., P.O. Box 35, W. Newton, Mass., Pap. L-123, 4 pp. [From *Appl. Mech. Rev. 13,* 215 (1960) March.]

It is shown that, just as in ordinary gasdynamics, the phase velocity of simple magnetosonic waves increases as the density increases under compliance with

$$[\, v_{pp} \,]_s > 0.$$

This fact is used for a qualitative investigation of time variation of simple waves. Conditions are found for formation of discontinuities, which agree with a known gasdynamics criterion, too. It is shown that self-similar waves are always rarefaction waves. Time dependence of density is given in a Lagrangian representation.

From authors' summary by P. G. Schwaar, USA

Services Available to GAS ABSTRACTS Readers

Photocopies

Photocopies of all articles abstracted in *Gas Abstracts*, except those enumerated here, are available from the Institute at cost:*

1) Russian Articles.—Abstracts are obtained from services specializing in this field. English translations can be supplied by arrangement with the appropriate abstractor.
2) U.S. Patents.—Printed copies can be secured at 25 cents each (remittance with order) from the Commissioner of Patents, Washington 25, D.C.
3) Books, Special Reports.—When a price is given in the abstract, these should be secured from a bookdealer or the publisher; when stated *free*, from the publisher.

Types of Photocopies

Depending on the "tightness" of the binding (which determines whether pages can be laid flat without breaking the binding), and the color of the paper and ink used in the original being copied, photocopies may take any of several forms:

1. Positive paper prints made by the reflex process.
2. Positive paper prints enlarged by xerography from microfilm negatives.
3. Negative photostats.
4. Positive photostats.

Choice of the method used must necessarily rest with the Institute. All photocopies are approximately the same size as the original material.

Cost of Service

The photocopy service charge is:

First 5 pages or fraction thereof of one article in one issue $1.50

Each subsequent 4 pages or fraction thereof of the above one article in the same issue.....$1.00

Invoices are rendered to the Institute's Members and Contributors only; payment in advance is required of others.

The Institute may, at its option, fill orders from non-Members and non-Contributors without payment in advance, but an additional charge of $1.00 to cover billing costs will be made on each such order.

Microfilm

Microfilm copies of articles abstracted in *Gas Abstracts* are likewise available at cost.* The material is photographed on 35 mm unperforated negative film at 5¢ per page, with a minimum of 50 pages, $2.50, per order. Invoices are rendered to the Institute's Members and Contributors only; payment in advance is required of others.

The Institute may, at its option, fill orders from non-Members and non-Contributors without payment in advance, but an additional charge of $1.00 to cover billing costs will be made on each such order.

Bibliographies and Literature Searches

The library will prepare bibliographies and make literature searches on a cost basis plus a service charge. A comprehensive statement detailing the problem must be presented with the request.

Gas Abstracts on Cards

The abstracts in each monthly issue are also printed individually on 5 x 8-inch cards. Each card bears at its top the author and subject headings under which it may be filed. As many copies of each card are supplied as there are headings on that card, enabling filing of the abstract under all of its headings, eliminating cross-indexing.

The annual subscription to *Gas Abstracts on Cards*, a mailing of 500-1000 cards each month, is $120.00 to U. S. addresses, $150.00 foreign.

Since the printing order for cards is based on the current number of subscribers, a subscription for this service commences with the month in which the order is received. Back numbers of *Gas Abstracts on Cards* are not available.

Back Numbers of Gas Abstracts

In response to an increasing number of requests from utilities, colleges, and technical libraries which have only recently learned of the reference value of *Gas Abstracts*, the Institute has taken steps to make available single numbers, volumes, or complete files of this publication to date, starting with Vols. 1 (1945) and 2 (1946), some numbers of which are out of print.

The latter numbers are reproduced by a photoprinting process from copies in the Institute's libraries, and Vols. 1 and 2 can now be purchased at $35 per volume, unbound; single monthly numbers are offered at $3 each.

Vols. 3 to date are available at current subscription prices, $18 per volume to U. S. addresses, $22 foreign. Monthly numbers are $2 each.

---

*In requesting and accepting photocopies or microfilm copies, the applicant agrees to the following:

1. The applicant desires this duplication solely for use in lieu of loan or manual transcription. Responsibility for questions of copyright that might arise in this copying, and in the use of the copies, is assumed by the applicant.

2. The applicant understands that the Institute does not sell the photocopies, but merely performs the service of copying at the applicant's request; the fee paid is exclusively for such service and is established on the basis of no profit to the Institute.

3. The Institute reserves the right at its own discretion to decline to make photocopies requested, or to limit the number of copies, within the principle of fair use of copyrighted material.

Publications Abstracted for GAS ABSTRACTS

Air Conditioning, Heating and Ventilating
Air Engineering
Air Pollution Control Association, Journal of
American Chemical Society, Journal of
American Gas Association Monthly
American Gas Journal
American Institute of Chemical Engineers, Journal of
American Society for Testing Materials Bulletin
Analytical Chemistry
Appliance Manufacturer
Applied Chemistry, Journal of
Applied Mechanics, Journal of
Applied Mechanics Reviews
Applied Physics, Journal of
Applied Spectroscopy
ARS Journal
ASHRAE J.
Australian Journal of Applied Science
Australian Journal of Chemistry

Basic Engineering, Journal of
Battelle Technical Review
Bituminous Coal Research
Brennstoff-Chemie (German)
British Coal Utilization Research Association Monthly Bulletin and Quarterly Gazette
Business Week
Butane-Propane News

California Oil World
Canadian Chemical Processing
Canadian Gas Journal
Canadian Journal of Chemical Engineering
Canadian Journal of Chemistry
Canadian Journal of Physics
Ceramics (British)
Chemical and Engineering Data, Journal of
Chemical and Engineering News
Chemical & Process Engineering
Chemical Education, Journal of
Chemical Engineering
Chemical Engineering Progress
Chemical Physics, Journal of
Chemical Processing
Chemical Reviews
Chemical Society, Journal of (British)
Chemical Society, Proceedings (British)
Chemical Week
Chemistry & Industry (British)
Coal-Heat
Coal Utilization
Coke and Gas (British)
College Placement, Journal of
Combustion
Combustion and Flame (British)
Communications of the ACM
Compressed Air
Computers and Automation
Construction Methods and Equipment
Control Engineering
Corrosion
Corrosion Technology (British)
Cost Engineering
Datamation
Design News
Drilling
Electronics
Engineering for Industry, Journal of
Engineering for Power, Journal of
Engineers' Digest (British)
Erdöl und Kohle (German)
Faraday Society, Transactions of (British)
Fuel (British)
Fuel Efficiency (British)
Fueloil & Oil Heat
Gas
Gas Age
Gas & Oil Power (British)
Gas Council Research Communications (British)
Gas Heat and Comfort Cooling
Gas Industries
Gas Journal (British)
Gas Service and Domestic Coke
Gas Times (British)
Gas- und Wasserfach (German)
Gas World (British)
Gazovaya Promyshlennost (Russian)
Heating, Piping & Air Conditioning
Heat Transfer, Journal of
Independent Petroleum Association of America Monthly
Industrial and Engineering Chemistry
Industrial Finishing (British)
Industrial Gas (American)
Industrial Gas (British)
Industrial Heating
Industrial Research
Industries du Gaz, Journal des (French)
Institute of Fuel, Journal of (British)
Institute of Gas Technology Research Bulletins
Institute of Petroleum, Journal of (British)
Institution of Gas Engineers Bulletins and Communications (British)
Instrumentation
Instruments and Control Systems
Izvestiya Akademii Nauk S. S. S. R. Otdelenie Khimicheskikh Nauk (Russian)
Khimiya i Tekhnologiya Topliva i Masel (Russian)
LP-Gas
Lubrication
Lubrication Engineer
Mathematical Aids to Computation
Mechanical Engineering
Metals, Journal of
National Aeronautics and Space Administration Memorandum
National Fire Protection Association Quarterly
National Gas Bulletin of Australia
National Petroleum News
Nuclear Science and Engineering
Nucleonics
Oil and Gas Journal
Optical Society of America, Journal of
Organic Chemistry, Journal of
Petroleum (British)
Petroleum Engineer, The (Drilling and Producing)
Petroleum Engineer, The (for Management)
Petroleum Refiner
Petroleum Technology Journal of
Petroleum Week
Physical Chemistry, Journal of
Physics and Chemistry of Solids (British)
Physics of Fluids (British)
Physics Today
Pipeline Engineer
Pipe Line Industry
Pipeline News
Power
Producers Monthly
Product Engineering
Progress (Pakistan)
Public Utilities Fortnightly

Refining Engineer
Research/Development
Research, Journal of, A. Physics and Chemistry
Research, Journal of, B. Mathematics and Mathematical Physics
Research, Journal of, C. Engineering and Instrumentation
Review of Scientific Instruments
Revue Generale du Gaz (Belgian)
Rivista dei Combustibili (Italian)

Science
Scientific Instruments, Journal of (British)
Stroitel'stvo Truboprovodov (Russian)
Svenska Gasverksföreningens Månadsblad (Swedish)
Technical News Bulletin
U.S. Bureau of Mines Bulletins, Information Circulars and Reports of Investigations
U.S. Patents
Uspekhi Khimii (Russian)
World Oil
World Petroleum